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TWO MISSISSIPPI RIVER BRIDGES are to be rebuilt, with new superstructures on the existing piers. The Chicago, Burlington & Quincy R. R. will rebuild its bridge at Quincy, Ill., replacing six double-intersection Pratt truss spans of 154 ft. with single-intersection Pratt truss spans. The old bridge was built in 1868, and has Phoenix posts, and these spans may be utilized for highway bridges over the tracks at yards, etc., which was the plan adopted when the Burlington bridge of the same railway was rebuilt. The old and new bridges will be alike in having through trusses for a single track, but the new bridge may be slightly wider. The draw span of 365 ft. has already been rebuilt and will be left unaltered. No work will be done on the piers, except to put on new copings and bridge seats. The contract has not yet been let and the plans are not fully completed. The Chicago & Alton R. R. will rebuild its bridge at Louisiana, Mo., the work extending over about a year. The bridge has a draw span of 440 ft., five spans of 158 ft., and one each of 226, 257 and 316 ft. Mr. H. C. Draper, the Chief Engineer, states that the new 226-ft. and 257-ft. spans will be built during low water this season, and that two of the 158-ft. spans will be rebuilt at the same time, much of the material from the old long spans being utilized in these new short spans. The draw span will be built during the winter, when the river is frozen over. For all this work the contract has been let to the Lassig Bridge & Iron Works, of Chicago. During the season of low water next year, the remaining spans (one of 316 ft. and three of 158 ft.) will be rebuilt. Only slight alterations will be required to the tops of the masonry piers. The commencement of work has been delayed by high water, but pile driving for the falseworks is now in progress. The old bridge was rebuilt in 1873.

AN UNUSUALLY HEAVY SINGLE SPAN RAILWAY bridge has recently been completed across the Androscoggin River on the line of the Portland & Rumford Falls Ry., in Maine. The bridge is located on the Otis Falls Branch of this road and consists of three 200-ft. 1-in. through truss spans, calculated for a live load of two 170-ton locomotives, followed by a uniform load of 4,800 lbs. per lin. ft.; Cooper's specifications being used. The bridge is on a skew of 25°. The wooden floor system, laid upon metal beams and stringers, consists of southern pine cross ties and guard rails, thoroughly bolted together and to the track stringers. The ties are 8 × 12-in. timbers, 14 ft. long, spaced 11¼ ins., c. to c.; the guard rails are 8 × 8-in. timbers, placed 6 ft. 3 ins. from the center of the track and notched 1½ ins. over every tie. In addition to these outside timber guard rails, there are inside guards consisting of a line of steel rails laid just inside of each of the main track rails. The foundations for this bridge were built by Mairs & Lewis, of New York, N. Y., and were described in Engineering News of May 27, 1897. The contractors for the superstructure were the Phoenix Bridge Co., of Phoenixville, Pa. Mr. R. B. Stratton is Chief Engineer of the Portland & Rumford Falls Ry.

A NEW DRAWBRIDGE of the bascule or hinged lift type is to be built across the Chicago River at State St., Chicago, Ill. The swing bridge now located at this point has become unsafe owing to the settlement of the foundations, and as the traffic crossing the river at State St. is very heavy, the Department of Public Works has begun the preparation of plans for a new structure, and the City Council will be asked to make a special appropriation for its construction at their next meeting.

THE CONTRACT BETWEEN THE BROOKLYN Bridge and the Brooklyn railway companies was signed on Aug. 23, whereby an agreement has been entered into between the trustees of the Brooklyn bridge and the presidents of the Brooklyn City Elevated Railway, the Kings County Elevated Railway companies and the principal trolley surface railway companies of Brooklyn, to run both classes of cars over the bridge to the New York terminus. Bridge trains will still run, but at longer intervals; and this service may ultimately be abandoned. The contract requires the trolley companies to begin altering the approaches to the bridge within 10 days and complete this work in six months. This work includes an entire rearrangement of the lines of the trolley roads near the Brooklyn entrance to the bridge. The Brooklyn Elevated Railway Company is to begin work in 60 days and finish within six months, and the Kings County Elevated Railway has one year in which to complete its work. These roads must pay the cost of all alterations on the bridge; these including three loop tracks, new platforms, stairways, elevators, etc., at the New York end. The Brooklyn Elevated will also change its motive power to electricity along its whole line, at a cost of about $1,500,000, while the Kings County line will use the bridge motors for the present. The cars of the elevated systems will run between the bridge trains on the present tracks, and the trolley cars will be operated on the roadways. The estimated cost of the necessary alterations at the New York end is $500,000.

ELECTRIC MOTOR CARS are to replace steam locomotives on the Chicago & South Side Elevated Ry., and when this change is made all the elevated railways in Chicago will be operated by electricity. Work has been commenced laying the third rail, under the direction of Mr. E. Klapp, Chief Engineer, and it is expected that the third rail and feeder cables will all be laid on the structure by the end of November. In the Sprague system of electric traction, which has been adopted, each car will have its own motors, all the cars of a train having electrical couplings so that the entire train is operated from the front car. On all the other elevated lines the front car only is fitted with motors, and is thus an electric locomotive, the other cars not being equipped with power.

THE HARDIE COMPOUND AIR LOCOMOTIVE, described and illustrated in our issue of June 24, 1897, and built by the American Air Power Co., made an exhibition run on the Sixth Avenue line of the Manhattan Elevated Railway on Aug. 19. The regular run from Rector St. to 58th St. was made in 19 minutes, with a train laod of 192 invited guests. It is said that the motor may be put into regular service shortly, to test the actual economy of the system. The trial run was successful in proving the ability of the motor to do the work required.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a grade crossing collision, which occurred Aug. 20 at the junction of the Lake Erie & Western R. R. and the Detroit & Lima Northern Ry., two miles northeast of Toledo, O. As a result of the carlessness of the crew of a freight train of the Lake Erie & Western, an excursion train on the other road was run into at the junction of the two roads. Some 36 persons were injured, 6 of them, it is said, fatally.

ELECTRIC POWER FOR PUMPING is under consideration by the Buffalo Water Department. Among the bids for a 30,000,000-gallon pumping engine received on Aug. 18, was an offer by the Buffalo Engineering Co. to instal four of the Quimby screw pumps (illustrated in Engineering News of June 18, 1896,) and drive them by four electric motors mounted on the same shaft. The Cataract Power & Conduit Co. offered to supply electric current to operate the motors at $30 per HP. per annum. It is said that steam power for water-works pumping in Buffalo now costs $60 per annum.

BUMPING POSTS OF EARTH are used with success in place of the usual wood and iron bumping post, on many of the spur tracks and blind sidings of the Pennsylvania R. R. These earth bumping posts consist of a heap of compacted clay or gravel about 10 ft. long and 5 ft. high, placed in the usual location at the end of the track. These heaps of earth offer sufficient resistance to stop the car and at the same time are yielding enough to prevent any great damage to its buffer blocks and draft rigging. After the collision the bumping post is repaired by the sectionmen who simply replace the dislodged earth with their shovels.

THE 24-HOUR SYSTEM OF TIME NOTATION was formally adopted, on May 1, by the Belgian Minister of State Railways. By the official notice sent out the hours of the day will thereafter be numbered from 0 to 24. The letters M and S, for matin and soir, will be suppressed, and the minutes between midnight and 1 o'clock will be indicated by a zero, followed by a period and the proper number of minutes; thus 0.45. Midday willl always be indicated by 12, and midnight by 0. The order also states that for a train arriving at a station at midnight it is to be written that it arrives at 24 of the day, during which the train has been in motion; but a train starting out at midnight leaves at 0 of the day it is to be in motion. The dials of all station clocks are to be changed by placing the figures from 13 to 24 beneath the existing figures from 1 to 12. The official railway guide of Belgium has already been changed to conform with this regulation.

A SYSTEM OF TELEPHONE COMMUNICATION for the New York state canal system is to be established and proposals are called for it, as stated in detail in our advertising columns. The system will connect the office of the Superintendent of Public Works with all the locks on the canal and with each state scow and steam dredge, wherever it may be employed on its section, also with the Section Superintendents' offices.

A LARGE ELECTRIC LIGHTING CONTRACT is to be let at Louisville, Ky., on Sept. 14, as noted in our advertising columns, being for lighting the city's streets for a term of 5, 10, 15 or 20 years. The present electric lighting company has 1,220 arc lamps of 2,000 c. p. in service, and any other bidder must, of course, establish his own plant. Bidders are requested to submit their own plans and specifications, and must take into consideration the fact that they will have to erect an overhead plant first and later put their wires underground.

ELECTRICAL EXPORTS from this country are steadily increasing, and one large company with its factory in the central states, reports recent orders for 16 complete street railway equipments, and fully 16,000 HP. in railway motors, besides orders for lighting machinery and railway generators alone. These orders came from England, France, Germany, Belgium, Italy Portugal, Japan, South America, and even Africa.

CIVIL SERVICE EXAMINATIONS for positions in the Department of Public Works of New York, N. Y., are announced as follows: Inspector of pipe and pipe laying, Sept. 14; topographical draftsman, Sept. 21. Mr. S. William Briscoe is Secretary of the Civil Service Commission, with offices in the new Criminal Court Building.

THE INCREASING USE OF CABLEWAYS in constructing engineering works requiring the transportation of large quantities of construction material is well illustrated by the adoption of this system for constructing the large power plant of the St. Lawrence Power Co., at Messina, N. Y., and the new Cornwall, N. Y., bridge across the St. Lawrence River. At Messina the cableway will have a span of nearly 1,400 ft., and will be supported by one fixed and one traveling tower. The traveling tower, operated by power, will move around the fixed tower as a center, and the cableway will have the Miller aerial dump and new pattern fall rope carriers. At Cornwall the cable way will be 1,250 ft. long between towers, and will span the Cornwall Canal and the foundation site of the bridge piers. All construction material for the bridge foundations will be shipped by the canal, and the cableway will take it direct from the boats to its place in the foundations. The contractors for the Messina, N. Y., work are the Lehigh Construction Co., and for the Cornwall bridge foundations Sooysmith & Co., of New York, N. Y. The Lidgerwood Mfg. Co., of New York, N. Y., furnished both cableways.

THE COST OF WIDENING THE CHICAGO RIVER sufficiently to secure 300,000 cu. ft. of water per minute for the Chicago Drainage Canal is estimated to cost $375,000 by the committee of real estate experts appointed by the Board of Trustees. This committee divides the cost as follows: real estate, $73,000; purchasing and rebuilding docks, $25,000; dredging, $75,000; construction of bypasses, $200,000.

FRAUDS IN THE WATER DEPARTMENT of the city of Chicago are reported in considerable detail in the daily press of that city, and considerable evidence has been collected in proof of falsification of the meter readings, while tampering with the books in the office has also been discovered. The bills of large consumers have been scaled down by wholesale. In one case a plant consuming about 275,000 gallons a month is said to have been paying, according to the city's books, for only about 40,000 gallons; while in another case the bills decreased month by month so regularly as to attract suspicion, the reduction being from 771,000 gallons in January, 1896, to 164,000 gallons in March, 1897. Mr. McGann, Commissioner of Public Works, proposes to adopt electric automatic registers for the meters, or a method of automatically printing the register on a tape, so as to do away with the present method by which the rate takers simply enter the meter readings in their notebooks. In some cases the meters are on the ends of private or branch pipe lines, as at the stockyards, and it is said that the pipes have been tapped behind the meters, and in order to prevent this, orders have been given to move the meters and put them close to the main connecting with the private pipe.

THE VICTORIA JUBILEE BRIDGE AT MONTREAL; GRAND TRUNK RAILWAY.

For some years past there have been rumors current to the effect that the celebrated tubular bridge across the St. Lawrence River at Montreal was to be replaced with truss spans, but these rumors have not generally received much credit. It is now true, however, that the tubular spans are to be replaced with truss spans, and the contracts for the work have been awarded, as already noted in our news columns.

When the Grand Trunk Railway was being built from Portland to Montreal the English projectors

FIG. 1.—GENERAL VIEW OF THE VICTORIA TUBULAR BRIDGE OVER THE ST. LAWRENCE RIVER; GRAND TRUNK RY.

saw at once that it would be necessary to build a bridge over the broad and swift St. Lawrence to obtain an entrance to Montreal. The famous engineer, Robert Stephenson, was called in to examine the ground and design the structure, and after an interesting and comprehensive series of investigations and tests he adopted the tubular form of bridge, then already in use for the railway bridge across the Menai Straits. These tubes were of boiler iron and were 16×20 ft. in sectional area, with a simple plate floor and roof instead of the cellular construction adopted in the Menai Bridge. The smoke and gases from the locomotives in this long iron tunnel made the atmosphere very foul, and within recent years, under instructions from Sir Henry Tyler, who was President of the Grand Trunk Ry. at the time, a strip of the plating along the center of the roof was removed, the roof being reinforced by riveting angle irons along each side of the opening. Rust and corrosion (from the products of combustion, damp, and the drippings of brine from refrigerator cars) have made inroads upon the ironwork, and while these did not reach such an extent as to impair the safety of the structure, yet they, in conjunction with the incapacity of the single track bridge to provide properly for all the traffic, led the company to decide upon erceting a new superstructure.

The first stone of the Victoria Bridge was laid on July 20, 1854, and the first train passed over on Dec. 15, 1859. The bridge is 9,144 ft. long, the total length of the ironwork being 6,592 ft. There are 24 piers and two abutments, containing 100,000 cu. yds. of masonry, the thickness of the piers at the water line being 18 ft., except for the two piers of the channel span, which are 28 ft. wide. There are 25 spans, 24 of these ranging from 242 to 247 ft. in length, and the center or channel span having a length of 330 ft. The height from the water to the bottom of this tube is 60 ft., and the bridge has a grade of 1 in 130 from each end to this span. The total weight of iron in the tubes is 9,044 tons, and the area for painting in each coat was 32 acres. The greatest depth of water is 22 ft., and the average rate of the current is 7 miles per hour. The contractors for the old bridge were Messrs. Peto, Brassey & Betts. Fig. 1 is a general view of the bridge. Fig. 2 shows in more detail one of the masonry abutments and some of the end spans, with the iron casings of the ends of the tubes, which form refuges for the trackmen. It also shows the side openings for ventilation, and the traveler used in cutting out the top plating for additional ventilation, while at the right appears one of the travelers used for painting and inspection of the exterior.

The masonry of the piers is now being extended on the upstream side, to meet the requirements of the enlarged superstructure, but this addition is only above the water table of the cut-waters of the piers, as the present foundations are ample for the new work. The masonry is of limestone ashlar, and the contractor for the extension of the piers is Mr. Wm. Gibson, of Beamsville, Ont. A part of the walls and portals of the abutments of the bridge will have to be taken down, and the upper portions of the piers (at their south ends) are also to be taken down to such an extent as to admit of lengthening the piers as above described. Examination of the masonry showed that the material removed would be unsuitable for use for the external masonry, but it may be employed for the backing. Each course of the new masonry is to be of the same depth as the course of the old masonry of which it becomes an extension, and all the masonry will be built of dimension stone, all faces being pick or hammer dressed. The vertical joints in each course must overlap those in the course below by at least 12 ins. The backing will be of squared or dimension stone, of the same thickness as the face stones. The following is an abstract from the specifications for this masonry work:

The face of the stones forming the ice breakers shall have a 2-in. margin draft all round, and shall be dressed off between to a uniform surface with a point or pick.

All these face stones are to be clamped together, both vertically and horizontally, with iron. The horizontal clamps to be 2½ ins. wide, ½-in. thick, 24 ins. long; these are to be turned down 2½ ins. at each end, and embedded their whole length and thickness in the stone. The vertical bolts are all to be 1 in. diameter, and to pass through the horizontal clamps and the vertical joints of the stones, to be let into the course below at least 9 ins. and to be secured thereto by fox-tail wedging.

Coping stones of piers and bridge-seats of abutments, shall not be less than 5 ft. in length, nor less than 30 ins. in width. The top and face of each stone to have a 2-in. tooled margin draft, and to be neatly bush-hammered between. String courses and pedestals to be dressed in the same way as copings. The sides and ends shall be dressed so that vertical joints shall not exceed ¼-in. in width. The ends will be fastened together, on top, by clamps 12 ins. long, 2 ins. wide and ¾-in. thick, let 3 ins. into each stone, two to a joint, and to be placed where directed. The whole of these stones to be set in full Portland cement mortar, made in the proportion of 1 part cement to 1 of sand.

Every stone of the masonry must be set in a full bed of mortar and beaten with a heavy wooden maul until a solid bearing has been secured; the vertical joints must be fully flushed and filled up, using for the purpose "swords" or rammers, and where necessary to insure perfect filling, grouting must be resorted to. Each course must be properly levelled throughout its whole extent.

The mortar must be composed of the best Portland cement, and clean, sharp, coarse and properly screened sand, thoroughly mixed in approved proportions; these will be generally 2 parts of sand to 1 of cement, but they may be varied at the option of the engineer, according to the quality of the material. The cement and sand must be well mixed in a dry state; then enough water must be added to make mortar of a consistency that can be properly handled by a trowel. Mortar must be made in small quantities and only as required. Re-tempering of mortar that has partly set will not be permitted.

The face joints of the masonry must be raked out to a depth of 1½ ins. and pointed with pure cement mortar.

The superstructure of the new bridge, which is to be called the "Victoria Jubilee Bridge," will consist of 24 spans of pin-connected, through, steel trusses, each 254 ft. long, c. to c. of end pins, and one of 348 ft. over the steamboat channel. The trusses will carry two railway tracks to be used by ordinary steam railway trains, as well as by electric railway cars, and the floor beam system will be extended beyond the trusses sufficiently to carry a 10-ft. roadway and a 5½-ft. sidewalk on either side.

The details of one of the 254-ft. spans are shown in Fig. 3. It has parallel chords and inclined end posts, and is divided into two panels of 25 ft. 4¾ ins., c. to c. of pins. The depth of truss is 40 ft., c. to c. of pins, and the width between trusses is 31 ft. 2 ins. c. to c. The top chord is of trough section, 28 ins. deep, having four web plates, a top cover plate and eight flange angles. The pins in this chord are 6, 7 and 7½ ins. diameter. The posts are of I-beams and built-up sections, and

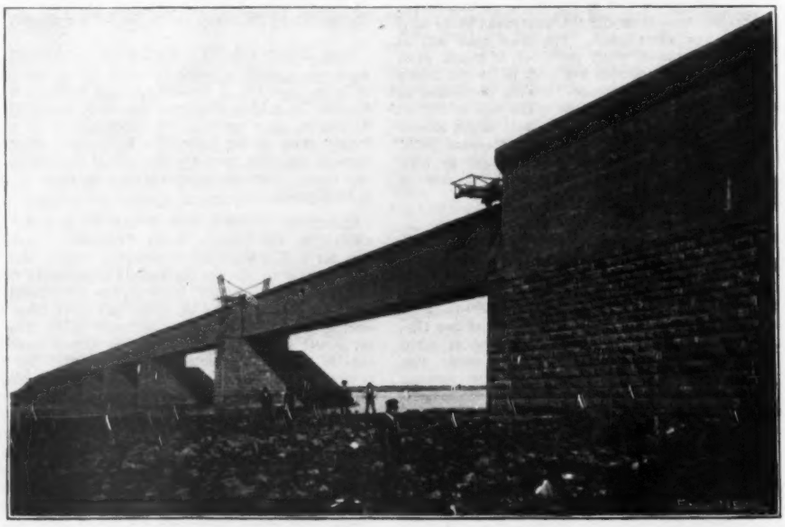


FIG. 2.—VIEW OF ABUTMENT AND END SPANS OF THE VICTORIA TUBULAR BRIDGE.

the diagonals are eye-bars, with turnbuckles on the counters in the two middle panels. The bottom chord is composed of 8-in. eye-bars, with 7½ in. pins, the thickness and number of bars varying with each panel. The end pins are 8½ ins. diameter. The floor beams are plate girders 66 ft. 3 ins. long, suspended from the pins by I-beam hangers, the girders extending beyond the trusses to carry the roadways and sidewalks. The girders are connected by longitudinal and diagonal brac-

ing. The trusses will be connected by transverse struts between the top chords, and between the posts, the latter struts being 15 ft. 1 in. below the top chords, giving a clear headway of 23 ft. 1½ ins. from base of rail to the lower struts of the overhead lateral bracing. There will also be the usual horizontal and vertical lateral bracing, as shown in the plan and cross section, Fig. 3.

Upon the central portion of these floor beams are carried eight lines of stringers of 24-in. I-beams, four under each track, 2 ft. 5½ ins. c. to c., the inner lines being connected by vertical diagonal bracing. Across these beams are laid pitch pine ties, 10×10 ins., 4 ins. apart in the clear, these ties being long enough to carry both tracks. There will be two tracks of standard gage, 13 ft. c. to c., with a guard timber outside each rail. On each cantilever end of the floor beams will be two lines of 20-in. I-beams for the roadway, and a 15-in. channel on the end of the beam. These carry the roadway timbers, which will be similar to the track ties, but 12 ins. apart. Upon these timbers will be laid a flooring of 4-in. plank for the roadway and sidewalk.

Across each end of each masonry pier (parallel with the bridge) will be laid seven 24-in. I-beams (100 lbs. per ft.), 19 ft. long, the ends of which will be riveted to the end floor beams. On each set of I-beams will be two wall plates 4×5 ft., 1½ ins. thick, upon which will rest the shoes of the trusses. The shoes at the expansion end will have nine rockers, 4 ft. 3 ins. long, 3¾ ins. wide, and 7 ins. high, the top and bottom having curved faces. A variation in temperature to the extent of 150° is provided for in the expansion bearings. Between the floor beams carried by the I-beams on the piers, are 15-in. I-beams which support the floor system across the pier.

The channel span of 348 ft. will have curved top chords to the main trusses, but the plans of this span have not yet been finally adopted.

The railway tracks will be used not only for ordinary trains, but also for electric cars, thus affording a more frequent service between Montreal and several small towns on the south shore. These cars will be run between the times of the regular trains, and interlocking switch and signal plants will be installed at each end of the bridge at the junction of the electric railway with the bridge tracks.

The trusses are designed for the following loads:

1.—The total weight of metal in them, amounting to 5,910 lbs. per lin. ft. of span.

2.—The weight of the wooden floor beams, planking, sidewalks, guard timbers, railings, rails and fastenings, etc., amounting, in the aggregate, to 2,800 lbs. per lin. ft. This, with the weight of metal, gives the assumed dead load of 8,710 lbs. per lin. ft. of span.

3.—A moving load in either direction on each of the two tracks, consisting of two consolidation engines and tenders coupled, each weighing 284,000 lbs. on a length of roadway of 54 ft., followed by a uniformly distributed train load weighing 4,000 lbs. per lin. ft. The distribution of the engine loads is shown in the accompanying illustration.

4.—A moving load in either direction on each of the roadways of 1,100 lbs. per lin. ft.

5.—A live load on each footwalk of 200 lbs. per lin. ft.

To provide for wind strains and vibrations in the 254 ft. spans, the bottom lateral bracing is proportioned to resist a lateral force of 450 lbs. per lin. ft. of span, 300 lbs. of this being considered as a moving load and as acting on a train of cars at a line 8 ft. 6 ins. above the base of the rail. The top lateral bracing is proportioned to resist a lateral force of 150 lbs. per lin. ft. of span. For wind strains in the 348-ft. span, 35 lbs. are added in each of the above cases.

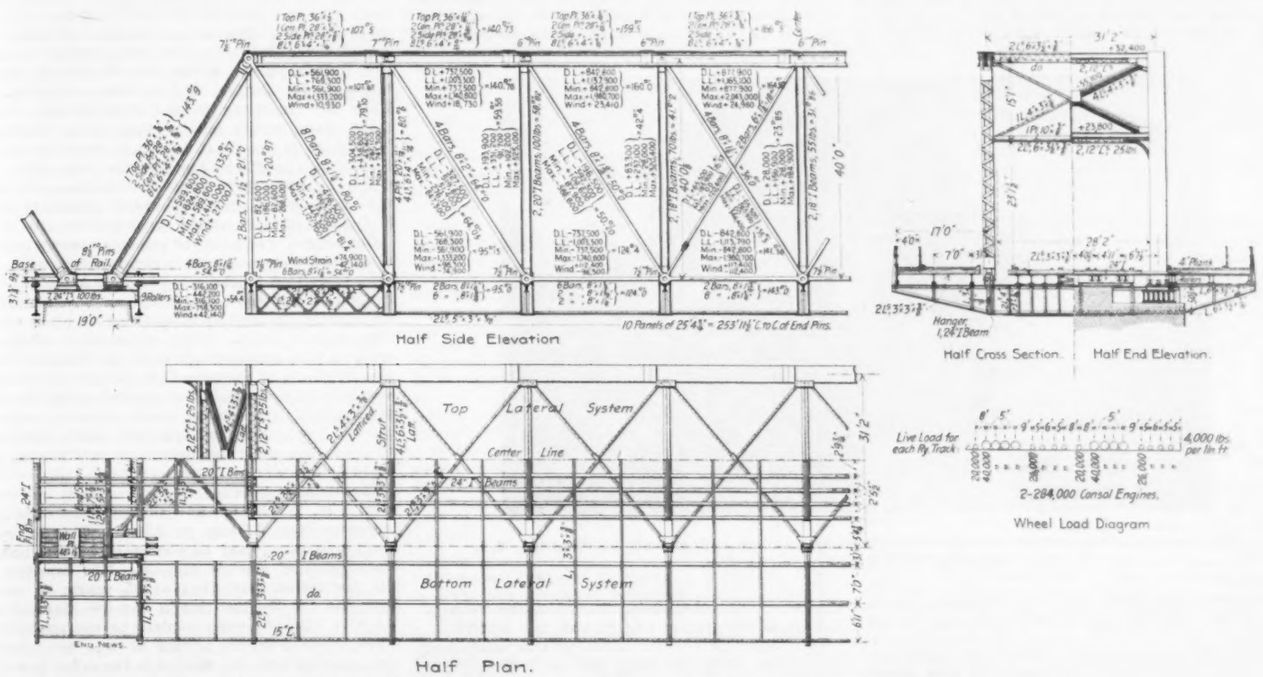


FIG. 3.—DETAILS OF NEW TRUSS SPANS FOR THE VICTORIA JUBILEE BRIDGE.

The following are some extracts from the specifications:

Bed plates (on masonry) for the trusses are to be made of cast-steel. These castings shall be free from blow holes, true to pattern and of a workmanlike finish. When tested in specimens not more than 2 ins. long, and of at least ½-in. uniform sectional area, it must give the undermentioned results:

Ultimate strength ..... 67,000 lbs.
Elastic Limit ..... 34,000 "
Elongation in 2 ins..... 20%

All steel must be made by the open-hearth process, and shall contain not more than 0.08% of phosphorus in acid steel, or 0.04% in basic steel, and each kind must be of uniform quality.

All tests for tensile strength, limit of elasticity and ductility, shall be made on samples cut from the finished material after rolling, and shall be at least 12 ins. long, and shall have a uniform sectional area of not less than ½-sq. in. All broken samples must show a silky fracture of uniform color.

When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

Soft steel shall have an ultimate strength of 54,000 to 62,000 lbs. per sq. in., with an elastic limit not less than half the ultimate strength and a minimum elongation of 25% in 8 ins. This steel must bend double, when cold, to close contact without sign of fracture on the outside.

Rivet steel shall have an ultimate strength of 50,000 to 58,000 lbs. per sq. in. and an elongation of 25%, and shall stand the bending test above specified.

Medium steel shall have an ultimate strength, when tested in samples of the dimensions given above, of 60,000 to 68,000 lbs. per sq. in., an elastic limit of not less than half the ultimate strength, and a minimum elongation of 22% in 8 ins.

This steel must stand bending 180° to a curve whose inner radius is 1½ times the thickness of the sample, without cracking on the convex side, either when cold, hot, or after being heated to a cherry red and cooled in water of 60° F.

Eye-bars of 8 sq. ins. of area or less, must elongate 15% in a gaged length of 20 ft.; must show a minimum elastic limit of 30,000 lbs. per sq. in., and develop a minimum ultimate strength of 58,000 lbs. per sq. in. For eye-bars of greater area, not exceeding 20 sq. ins. in section nor 2 ins. in thickness of bar, a reduction will be allowed to a minimum requirement of 56,000 lbs. ultimate strength, 29,000 lbs. elastic limit, and an elongation of 10% in a gaged length of 10 ft.

Eye-bars tested to destruction and fulfilling the above conditions shall be accepted even though they break in the head, if not over one-third of the bars tested break in this manner.

Pins made of either soft or medium steel shall, on specimen test pieces cut from finished material, fulfil all the requirements of the grade of steel from which they are rolled, excepting the elongation, which shall be decreased 5% from that specified.

Pins up to 6 ins. diameter shall be rolled. Pins exceeding 6 ins. in diameter shall be forged under a steam hammer striking a blow of at least 5 tons. The blooms to be used for this purpose shall have at least three times the sectional area of the finished pins.

After pins have been manufactured to diameter, they shall be carefully and uniformly heated to a medium orange color in a closed furnace, and not in contact with the fuel, after which they shall be buried in warm dry sand or ashes until cool.

All pins more than 5 ins. diameter shall be bored through the center.

Punched rivet holes, pitched two diameters from a sheared edge, must stand drifting until the diameter is one-half larger than the original hole, without cracking the metal.

All holes for field rivets, excepting those in connections for lateral and sway bracing, shall be accurately drilled to an iron templet, or reamed while the connecting parts are temporarily put together.

The several parts composing a riveted member shall be so accurately punched and reamed, that upon being assembled, connecting holes shall be truly opposite. If

they are not they may, if the inaccuracy does not exceed 1-16-in., be still further reamed to bring them exactly into line.

The heads of eye-bars and enlarged ends of rods may be made by upsetting or forging into shape. Welds in the body of the bar will not be allowed, except to form loops of laterals, counters, sway rods or unimportant details.

The eye-bars shall be annealed, and must be perfectly straight before boring, and must be free from all flaws or defects and of full thickness in the necks. Welds in the body of these bars will not be allowed. The heads of these bars must be so proportioned and made that when tested to destruction, the bars shall break in the body of the original bar rather than at any part of the head or neck, and shall be made by upsetting, rolling or forging into shape.

Bars which are to be placed side by side in the structure shall be bored at the same temperature and of such equal lengths that on being piled on each other the pins shall pass through the holes at both ends without driving.

The pins shall be turned accurately to gage and shall be straight or smooth; chord pins up to 4½ ins. diameter shall fit the pin holes within 1-50 in.; for pins of a larger diameter the clearance may gradually be increased to 1-32-in. for pins of 6 ins. diameter and over. Lateral pins shall fit the pin holes within 1-32-in.

The open sides of all compression members shall be stayed by batten plates at the ends and diagonal lattice work at intermediate points. The batten plates must be placed as near the ends as possible, and shall in length be not less than the greatest width of the member, or 1½ times its least width. The size and spacing of the lattice bars shall be proportioned to the size of the member.

The trusses shall be given a camber, by making the panel lengths of the top chord longer than those of the bottom, in the proportion of ⅛-in. to every 10 ft.

The shop painting will include one coat of paint to all inaccessible parts, and two coats after erection, all other parts being given one coat of raw linseed oil. Pin holes and planed surfaces will be coated with white-lead and tallow. In the field, the structure will be given two coats of paint. All paint will consist of 12 lbs. of pure red lead and 10 ounces of lamp black per gallon of paint, thoroughly mixed with raw linseed oil.

The design of the bridge has been prepared under the direction of Mr. Joseph Hobson, Chief Engineer of the Grand Trunk Ry., to whom we are indebted for blue-prints and specifications, etc. Ten of the trusses are now under construction by the Detroit Bridge & Iron Works, of Detroit, Mich., six by the Dominion Bridge Co., of Montreal, and nine by the Union Bridge Co., of New York city. The whole 25 spans will, however, be erected by the Detroit Bridge & Iron Works.

STEAM PILE DRIVERS FOR DRIVING SHEET PILING FOR SEWER TRENCHES.

The accompanying view shows a steam sheet pile driving apparatus used on the Allen Ave. sewer construction at Providence, R. I. A carriage mounted on wheels and spanning the trench carries two sets of leaders, one set over each line of sheet piling. The hammers are raised in the leaders and the plank used for the sheeting is placed under them and guided by the leaders. After steam is turned on the driving goes on automatically. A letter from the Vulcan Iron Works, of Chicago, Ill., who furnished the steam pile drivers for this machine, states that 150 lin. ft. of 4 and 6-in. sheeting in a 28-ft. trench was driven in ten hours on this work. In our issue of Jan. 28, 1897, we gave some very carefully prepared records of sheet pile driving by steam hammers in the construction of the West Bluff sewer system at Peoria, Ill.

STEAM SHEET PILE DRIVING APPARATUS USED ON THE ALLEN AVE. SEWER, PROVIDENCE, R. I.
Vulcan Iron Works, Chicago, Ill., Builders.

THE DEFINITE PROJECT FOR THE METROPOLITAN RAILWAY OF PARIS.

On July 7 the Municipal Council of the city of Paris adopted the report presented by Andre Berthelot, representing the special Metropolitan Commission, and laying down a definite project for the construction and the granting of a concession for the metropolitan railway of Paris. Without going into the detail of route, some notes upon the methods adopted for building this system will be of interest as abstracted from "Le Genie Civil." The essential features of this project are electric traction, the building of the substructure by the city and the operation of the system by a contractor who shall take charge of the work of equipping the system and furnish the material.

The reasons given for adopting this method of proceeding with the work are as follows: The city can secure the necessary capital for construction at a lower rate of interest than any private corporation, say, 3.3% as compared with 5%; and no private company could raise the capital required, about $40,000,000, without a guarantee of interest by the city. The Municipal Council also believes that the only means of protecting the interests of property holders on the line lie in this direct construction by the city; and for the direction of such work the engineers of the city and the municipal employes are evidently superior to any other agents by reason of their intimate knowledge of the subsoil of Paris, acquired in conducting analogous work. The city, however, does not deem it wise to equip the system, and leaves this work in the hands of the parties securing the concession for operating the lines. The electric installation is relatively new in type, and "the contractor should make the tools which he is supposed to afterwards use." This contractor can then organize his technical operation as seems best to him, without being handicapped by original arrangements over which he had no control; and, finally, to avoid all sources of complaint on his part, the city even leaves in his charge the arrangement of the station approaches. This division of interest in the actual construction not only lightens the burden imposed upon the city, but it also requires the operating party to invest a larger sum in the initial enterprise and to thus increase the guarantee obtained from him.

The total estimated expenditure by the city of Paris for the execution of this metropolitan system is about $35,000,000; and it expects to realize this sum by a loan based upon a tax of one cent per passenger which the operating party engages himself to turn over to the city. This differs essentially from the system of great monopolies conceded to the gas and the omnibus companies of Paris, which are founded upon a division of the profits. The present plan was adopted to avoid a repetition of the frequent legal disputes with the two latter companies. At 3.3% interest on this loan, or $1,100,000 annually, a traffic of 110,000,000 passengers would be required to meet this charge. The city engineers estimate that this figure will soon be reached, and during construction the interest charge will be embraced in the general budget.

The construction will be divided into three stages, and the first stage will include the building of a line from the Vincennes to the Dauphine gate; a circular system along the outer boulevards, and a line from the Maillot gate to Menilmontant. These lines would aggregate 26 miles in length, and eight years are allowed for building them, though the city hopes that one or two of these lines may be completed by 1900, and the whole of them by 1902. The second stage of construction would cover lines from the Clignaucourt gate to the Orleans gate; under the Boulevard Strasbourg to the Bridge of Austerlitz, and from the Park of Vincennes to the Place d'Italie. The third stage would include lines from the Place Valhubert to the Quai de Conti; from the Palais Royal to the Place du Danube, and from the Opera to Auteuil, by way of Grenelle. By 1905 the engineers of the city would expect to have 35.3 miles of this railway in operation.

One month was given to possible bidders for the concession to present their observations upon the plan submitted by the commission. After that the Prefect of the Seine appointed an administrative commission charged with selecting the plans which seemed best to it. This commission discussed matters with representatives of the General Traction Company of Paris and the Societe du Creusot, and also with a special committee of the Municipal Council. As a final result of this congress certain conditions and projects were definitely adopted, the most important of which may be noted as follows:

The distance between tracks has been increased from 1 m. to 1.30 m., and the width of carriages increased from 1.90 m. to 2.10 m. This enlargement was recognized as necessary for the proper installation of electric motors. The duration of the concession was fixed at 35 years; to count from the day the last line in any one stage of the work is handed over complete to the contractor. These three different groups of lines were finally to be handed over to the city in the order in which they were conceded; but the contractor was to remain in control of the whole until the last group was turned over to the city, upon condition of paying for the lines on which time had expired an annual sum amounting to 45,000 francs per kilometre, or about $14,518 per mile. At the expiration of all concessions the city will enter, without any payment, into possession of the whole system, including the necessary plant for operation, electric generating stations, repair shops and depots.

The city reserves the right after 1910, at which date the monopoly of the Omnibus and Tramway Company expires, to take possession of all means of transport in the city. In this case the contractor for the metropolitan system would receive an annuity of 45,000 francs per kilometre, until the nominal expiration of his concessions.

The price of ordinary passage on the system has been lowered to the uniform rate of 3 cts. for the course. But a first-class ticket has been provided costing 5 cts. Up to 9 a. m. the passenger will also be entitled to a return-ticket by paying 4 cts.; and the children of any public school, traveling together in charge of a teacher, only pay 1 ct. fare. The creation of the first-class fare is intended to compensate the operating party for the reduction of fares noted. Under these conditions it is estimated that a traffic of about 130,000,000 passengers annually will be necessary to enable the operator to pay his expenses and recoup the

capital invested. As before remarked, 110,000,000 passengers will be sufficient to pay the city's interest, and it is evident that at first the operating party takes more risks than the city itself.

The minimum number of trains is fixed at 135 per day, each way, and the maximum speed is 36 kilos., or 22.32 miles per hour. The total length of each train cannot exceed 72 m., or 236.16 ft. The Compagnie Generale de Traction and the Societe du Creusot have practically undertaken to operate the system, but they will not do this directly. They engage themselves, six months after the public declaration of contract, to form a company with a capital of 25,000,000 francs, with a council of administration made up exclusively of Frenchmen, and the managing director agreed upon by the city of Paris, which latter body can also demand his removal. But before this scheme can be realized the approval of the French Assembly is necessary; and "Le Genie Civil" believes that it will be difficult to there adjust the many conflicting interests and demands.

FAILURES OF GAS ENGINES AT ELECTRIC LIGHTING STATIONS.

The use of gas engines instead of steam engines to furnish power for driving electric generators has for some years been heralded as the coming great improvement in the engineering of central lighting and power stations. The fact that gas engines are now running which show a fuel consumption as low as 1 lb. of coal per brake HP., which is considerably lower than the lowest figures that have ever been obtained from any steam engine, is a strong argument in favor of the adoption of the gas engine, but nevertheless engineers show a great hesitation in substituting the gas engine for the steam engine in large plants. One cause of this hesitation is that sufficient information concerning details of construction of existing gas-engine electric plants, which may serve as precedents, is not yet available. Few electrical contracting engineers and still fewer capitalists care to venture into the comparatively new field of experiments on driving of dynamos by gas engines. There is less labor for the designer, and less financial risk, in copying an existing plant driven by steam engines.

Before any rapid extension of the use of gas engines in electric stations can be expected, there must be accumulated the records of a considerable number of precedents and information concerning both successful and unsuccessful plants which may serve as a guide to the designing engineer, showing him what features of design to adopt and what to avoid. Records of failures are often more instructive than records of success, and success in any new line of invention is usually reached only after a period of failures.

About a year ago a failure of a gas-engine driven electric lighting station took place in Aurora, Ill., and steam engines were substituted for the gas engines. The failure in that case was apparently due to some defect in the design of the engines, which were of comparatively new and untried make, which caused them to give trouble when heavily loaded. The same trouble might have taken place with steam engines if they had been poorly designed for the work required of them, and therefore no argument against gas engines in general can be derived from this particular case.

Three failures of gas engines for driving electric plants in Great Britain were recently noted in the London "Electrician," namely, at Belfast, at Morecambe and at Coatbridge. In each of these places it was decided to adopt steam after a trial of gas engines. Some details of the case at Coatbridge, in which gas engines were used from March, 1894, to June, 1895, and were then replaced by steam engines, are given by the "Electrician" as follows:

The equipment of the machinery room (in 1894) comprised three generating sets, each consisting of a 120-HP. gas engine, rope-geared to a 50-K-W. Mordey alternator. The gas engines were double-acting, two-cylinder, side-by-side type, and they worked on the "Otto" cycle, at 180 revs. per minute. The governing of these engines was by graded charge, down to one-third of full power, below which explosions were missed. Each engine shaft carried three flywheels, the middle one of which was grooved for ropes. The system was arranged for the alternators to be run in parallel. Gas fuel was generated from anthracite in a couple of generators somewhat resembling the "Dowson" generator. Two small vertical boilers supplied steam to the gas generators. A small gasholder served to regulate the supply of gas.

From March, 1891, to the end of June, 1895, Coatbridge station was run on the plan just described, the load on the station being so small as, not altogether unfortunately, to obviate the engines being run very often with the alternators in parallel; for during the greater part of the time one alternator sufficed. There were times, however, when the alternators were run in parallel, sometimes fairly successfully, at other times, we fear, with not altogether desirable consequences. At the beginning of July, 1895, the gas plant was thrown out of commission, the new steam plant, which had been erected during the previous few months, being ready for work. This plant comprised two Lancashire boilers and three vertical compound non-condensing Brush steam engines. Each boiler measures 26 ft. in length and 7 ft. in diameter, and is provided with two Vicar's mechanical stokers, the hoppers of which are stoked by hand from the boiler front floor. A bituminous slack coal is burned, costing 4s. 6d. per ton delivered, and an average evaporation of 7 lbs. of water (feed temperature of 120° F.) is obtained. The engines are each of 100-HP., and run at 208 revolutions per minute. Up to the present these engines have worked non-condensing; but there is now in course of erection a Worthington tubular surface condensing plant, which, when it is put into service, may be expected to effect a considerable saving in steam.

It is impossible to present the results of a separate and complete year's working of the gas engines; but the nine months of 1894 afford means for an approximately correct comparison with the full year's working under steam, in 1896. It will be noticed that the output of the station was much lower in 1894 than in subsequent years; and it may be thought that this renders the comparison unfair to the gas-power system. We believe, however, that not a little of the improvement in the output of the station is attributed by its managers to the greater confidence consumers have acquired since it has been run by steam. Be this as it may, we are compelled to take the figures as they stand. One of the most startling facts shown in Table I. is that the gas engines cost much more for fuel than has the steam plant. In face of the fact that it is claimed as the chief advantage of the gas engine that it is thermodynamically a much more efficient motor than the steam engine, this result appears at first sight inexplicable. But the explanation lies in the comparatively high price paid for fuel for the gas generators, by reason of the necessity to use smokeless anthracite rather than cheap local bituminous coal. We understand that during the greater part of the time of using gas power a price of 18s. per ton was paid; whereas now local slack costing but 4s. 6d. per ton is used. Estimating the weights of fuel used in the three periods, we arrive at the following results:

	1894.	1896.
Coal, in tons per annum.....	294.4	944
Coal per unit generated, in pounds.....	26.4	35.3

A Comparison of Costs of Working of Coatbridge Electric Supply Station running by Gas Power and by Steam Power.

	1894.	1895.	1896.
Steam-engine running		July to Dec.	Jan. to Dec.
Gas-engine running..	April to Dec.	Jan to June	....
Units generated	25,000	51,000	59,600
Cost of fuel	£265	£305	£212 8s. 4d.
Cost of fuel per ton, for gas	18s.	18s.	....
Cost of fuel per ton, for steam....	....	4s. 6d.	4s. 6d.
Cost of oil, waste, stores, &c..	£130	£160	£84
Salaries and wages at station	£375*	£482	£500
Salaries and wages on mains..	£182	£142	£166
Net loss on year's working..	£1,000 (9 mos.)	£1,461	£663
Cost of fuel per unit generated	2.545d.	1.435d.	0.855d.
Cost of oil, waste, stores per unit generated.	1.25d.	0.753d.	0.338d.
Salaries: Wages at station per unit generated	3.60d.*	2.27d.	2.03d.
Net loss per unit generated..	9.6d.	6.88d.	2.67d.

*Exclusive of wages paid to gas-engine attendants.

Notwithstanding the greatly increased cost of running the station in 1894 per unit of power as compared with 1896, the "Electrician" says that the figures show that the gas-driven station is not thereby proved to be a commercial impossibility, and it has still great hopes of its success. The high fuel cost was due to the use in the gas producers of an expensive coal, costing 18s. per ton, as compared with cheap coal used in the steam boilers, costing 4s. 6d. The mistake in this case was in the adoption of a gas generator which required the expensive fuel. The high cost of "oil waste and stores" in 1894 was largely due to cost of ignition tubes, four new tubes being used on each engine each day, to the fact that the lubricating oil was used in excessive quantities and was not refiltered and used over again. These costs, the "Electrician" thinks, might be reduced one-third. The decrease in salaries and wages in 1896 is said to be due to more efficient administration and management, and not to the substitution of steam for gas-engines.

It is apparent from the Coatbridge trial that an efficient gas driven electric plant must be provided with storage batteries, by use of which each engine in commission may be driven at its economical loading, thereby saving the great loss of gas which takes place on recovery at light loads. On this point the "Electrician" says:

Probably the most serious objection to the gas engine arises from its behavior at a low fraction of full load. If governed by a graduated charge of fuel and air, and working on the "Otto" cycle, the consumption of fuel rises at an extremely rapid rate as the load falls towards zero. If, on the other hand, a better economy of fuel is obtained by miss-fire governing, the straight-line regularity in the law of its consumption is marked by the absence of any regularity whatever in the speed. This defect is all the more serious when the engines are driving dynamos without battery storage, and more especially when the machines are alternators coupled in parallel, this last being the condition that existed at Coatbridge.

CHINA'S TOTAL FOREIGN COMMERCE in 1896 was $260,208,000, as compared with $245,700,000 in 1895. Of the total of last year $158,301,000 was in imports and $102,243,180 in exports.

THE COMMERCE OF THE TRANSVAAL in 1896, says the "Revue du Commerce Exterieur," was $67,936,000 in value of imports and $40,000,000 in exports. The chief imports, in order of value were machinery, cereals and flour, clothing, iron manufactures, railway materials, wood, animals and leather manufactures.

AN INTERNATIONAL CONGRESS OF COMMERCE is being organized by the Syndical Union of Brussels, to hold its sessions at the Exposition now open in that city from Sept. 6 to Sept. 11. The Congress will be under the presidency of M. Nyssens, Belgian Minister of Industry and Labor, and the questions to be discussed are those especially relating to industrial property, commercial law, industrial labor, political economy and transportation. Through the U. S. Department of State all Americans interested in these topics are invited to take part in the proceedings.

A PERUVIAN PERMANENT EXHIBITION of all classes of manufactured goods is to be established by the government of that country at Lima, Peru, and the exposition will be opened on Dec. 9, next. The government of Peru proposes in this manner to foster trade and offers advantageous terms to American manufacturers. All exhibits will be exempt from custom and consular fees, and exhibitors have the option of showing their goods for six months, or longer if special arrangements are made. It is noted that preference will be given to manufactures most used in Peru; such as agricultural implements, mining machinery, electrical appliances of all descriptions and labor-saving machinery. Any further particulars, rules, regulation and application blanks can be obtained by addressing Mr. Carlos G. Estenos, Acting Consular General of Peru, 19 Whitehall Street, New York city.

A NEW TYPE OF DIRECT-ACTING PUMPING ENGINE.

Mr. Luigi d'Auria, of Philadelphia, a few years ago invented a new system for the utilization of the expansion of steam in the direct-acting non-rotative pumping engine, and for some time past he has been engaged in developing the system through its experimental stages. The experiments have proven successful and he is now prepared to put the pump on the market.

Mr. d'Auria is an Italian, who, prior to 1876, when he came to this country, was an officer in the corps of Military Geographical Engineers of the general staff of the Italian Army. He had previously been a lecturer on Applied Mechanics in the Royal School for Engineers connected with the University of Naples. After visiting the Centennial Exhibition in 1876, he determined to remain in this country. His main engineering work since has been done in connection with the U. S. Engineer corps, in investigating the laws of currents in tidal rivers. He has been a frequent contributor of mathematical papers to the Journal of the Franklin Institute, and in 1883 he was a member of the Board of Examiners of the International Electrical Exposition held in that year by the Franklin Institute. About ten years ago, while temporarily employed in the Philadelphia water department, he became impressed with the great lack of economy in direct-acting non-rotative

pumping engines, and began a purely mathematical investigation of the question of working such engines with cut-off valves so as to utilize the benefits of the expansion of steam which are realized in the more expensive flywheel pumping engines. The result of this investigation led to his obtaining a series of patents involving several applications of his system, and to a line of experiments which have led up to the final design of the engine, which we now illustrate.

The vital defect of all ordinary direct-acting pumping engines, whether single cylinder or duplex, is that with uniform resistance of the water column pumped against, steam has to be carried in the steam cylinder at full pressure to the end of the stroke, all the gain due to expansion, which is utilized in flywheel engines, being lost. This defect was to a considerable extent overcome in the old Cornish vertical beam engine, in which a heavy pump rod, beam and "bob," or counterweight, were put in motion by the action of the steam in the earlier portion of the stroke, and then, when steam was cut off, expanding during the remainder of the stroke, the inertia of these heavy moving parts caused them to assist the decreasing steam pressure in raising the pump plunger to the end of its stroke. During this rapid down stroke of the steam piston and up stroke of the pump plunger, the barrel of the pump was filled with water, which was, on the slow return stroke, forced out of the pump by the descent of the heavy pump rod.

In the Worthington High Duty pumping engine the expansion of steam is also utilized by causing the surplus pressure upon the steam piston above the resistance of the pump piston at the earlier portion of the stroke to be used in forcing two auxiliary plungers into two oscillating hydraulic cylinders which face at an angle opposite the direction of motion at the beginning of the stroke, are at right angles to this direction at the middle, and are at an angle towards the motion at the end of the stroke, when they assist the expanded steam to overcome the resistance of the pump.

In the d'Auria pump the storing and restoring of the surplus energy of the steam exerted during the first half of the stroke over that necessary to overcome the resistance of the plunger is accomplished by another means. This means is known as the "water-governor," which is simply a closed loop of pipe filled with water, the ends of which pipe enter the two ends of the water cylinder (located between the steam and the pump cylinders), in which cylinder a plunger attached to the piston rod is driven to and fro at each stroke of the pump. Imagine the water which fills the pipe of this governor to be at rest, and the engine to be about to begin a stroke towards the right. The steam cylinder meets the resistance not only of the head of water which resists the motion of the pump piston or plunger, but also the inertia of the mass of water contained in the governor. The surplus of the steam pressure in the steam cylinder above the resistance of the pump plunger sets the mass of water in the governor in motion at a gradually accelerated velocity. After steam is cut off and expansion has taken place down to the point at which the pressure on the steam piston is less than the resistance of the pump plunger the inertia of the water in the governor, now moving at a high velocity, brings an extra pressure on the pump plunger and assists the expanding steam in driving the plunger through the remainder of its stroke. The energy of the moving water in the water governor is thus gradually taken out of it, and its velocity is retarded until it finally comes to rest. If the weight of the moving mass of water, the dimensions of the chamber and pipes of the governor, the sizes of the water and steam cylinders, and the point of cut-off of the steam in the latter are all correctly proportioned and arranged, then the amount of energy which is stored in and restored by the moving mass in the water governor will be precisely equal, friction excepted, to the surplus of energy which is exerted in the steam cylinder during the first half of the stroke over the energy overcome in the pump cylinder, and also to the deficiency of energy exerted in the steam cylinder below that overcome in the water cylinder during the latter half of the stroke. Any excess of energy remaining at the end of the stroke is safely absorbed by steam cushioning, lengthening the stroke somewhat, and filling the clearance space with steam of high pressure ready to do work in the return stroke. Means are provided for preventing the pump over-running its stroke and striking the end of the cylinder on account of any sudden reduction of resistance. The plunger of the governor has a series of holes cut in it, so placed that when they pass beyond the limit of their normal stroke they are uncovered by the edge of the flange which forms the bearing surface of the plunger, thus making a by-pass of the water in the governor. Through these holes the water passes, and its friction in passing through them and through the narrow space around the plunger soon brings the latter to rest. In large pumping engines an additional safety device is provided, which in case of a sudden release of pressure on the pump, caused by a break in the main, throttles the liquid in the compensating device and closes the throttle of the engine at the same time.

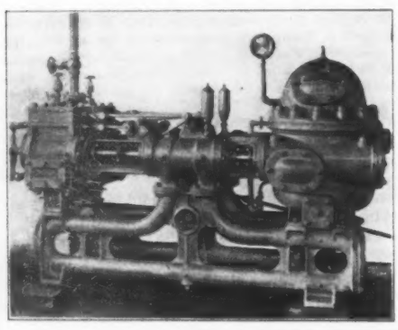


Fig. 1.—Duplex Steam Pump, 6 x 4 x 6 ins., with d'Auria's Compensating Device.

Fig. 1 shows one of the smaller sizes of pumps made by Mr. d'Auria, built by I. P. Morris Co., of Philadelphia. It is one of the ordinary duplex type with steam cylinders 6 × 6 ins., and water plunger 4 ins. diameter. The movement of the piston on one side controls the steam valve on the other side, as is usual in duplex pumps, this arrangement giving a perceptible pause in the motion of the plunger at each end of the stroke, and allowing time for the water valves to seat themselves properly before the beginning of the return stroke. The steam valves differ from those of an ordinary duplex pump in being of the "rider" type, the cut-off valve riding on top of the main valve, and adjustable, as to the point of cut-off, by hand. The pipes of the water-governors, there being two in a duplex pump, are conveniently built into the bed plate of the pump. This small pump has given in a test a duty of 26,200,000 foot pounds, corresponding to 76.6 lbs. of steam per pump horse-power per hour. The pump developed 6.87 HP. This duty is remarkably good for a pump of such small size, and is equal to that commonly obtained from compound duplex pumps of 75 or 80 HP.

With one of the experimental pumps, built by Mr. d'Auria, 12 ins. diameter by 12 ins. stroke, a speed of 180 ft. piston speed per minute has been obtained, and a duty of 35,000,000 foot pounds per 100 lbs. of coal, which is from two to three times the duty which might be expected of an ordinary direct-acting non-condensing pump of the same size. It was tested under all conceivable variations of load, such as suddenly reducing the water pressure, pumping air and water combined, air with one end of the pump and water with the other, etc., without causing any damage or difficulty.

Fig. 2 shows the latest design by Mr. d'Auria that of a 3,000,000-gallon compound condensing pumping engine, which is now being built. It is a compound duplex engine with steam cylinders 10 and 20 ins. diameter and 18 ins. stroke, and water cylinder 10 ins. diameter. This engine is expected to be completed in November, when we hope to be able to give a fuller description of it. It is designed to work against 100 lbs. pressure, and is expected to give a duty exceeding 100,000,000 foot pounds per 1,000 lbs. of dry steam.

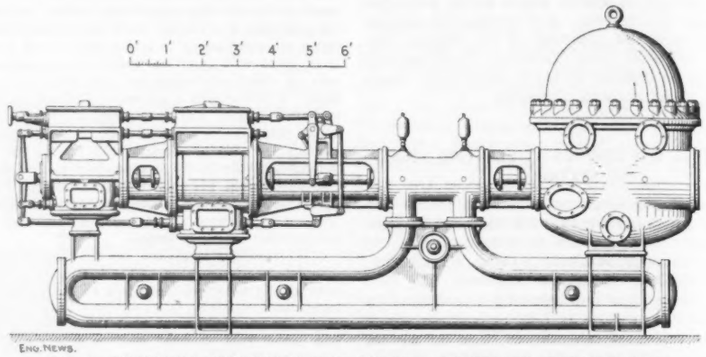


FIG. 2.—COMPOUND DUPLEX PUMPING ENGINE, 3,000,000 GALLONS CAPACITY.
Designed by Luigi d'Auria, Philadelphia, Pa.

Further information concerning the d'Auria engine can be obtained by addressing the d'Auria Pumping Engine Co., 905 Walnut St., Philadelphia.

THE DANUBE RIVER SIDE-WHEEL STEAMBOAT "FRANCIS JOSEPH I."

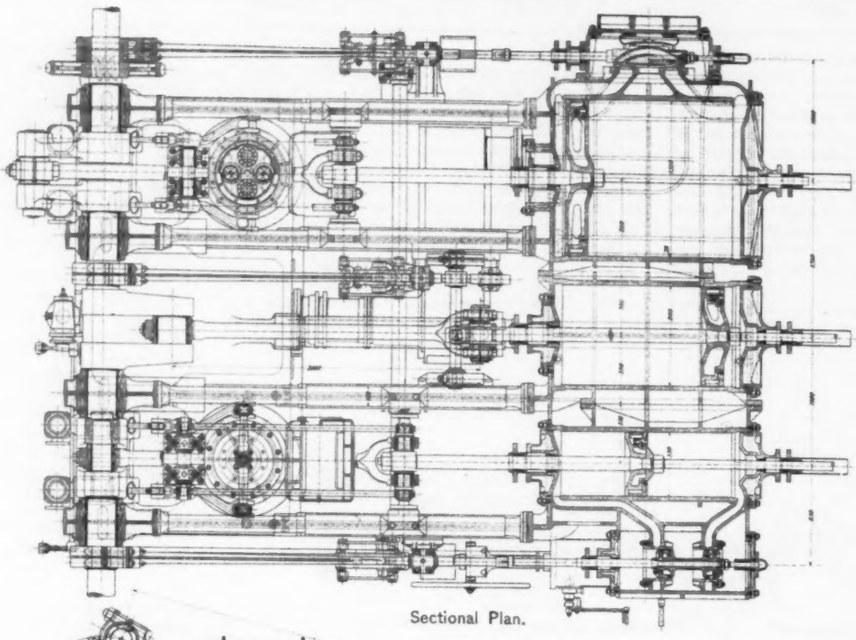
(With two-page plate.)

An interesting example of foreign practice in the construction of the side-wheel steamboats so familiar to the inland and coast waters of this country, is illustrated on our two-page plate this week. This steamer was built by the Danubius-Schoenichen-Hartmannschen shipbuilding firm of Budapest, Hungary, and is one of the fleet of four vessels plying the Danube River between the city of Semlin, in Austria, and the Black Sea port of Galatz. Its designers were Mr. Theodor Hallamassek and Mr. Adrian von Overbeeke, of the engineering staff of the firm. For the description and illustrations we are indebted to the "Zeitschrift des Vereines Deutscher Ingenieure."

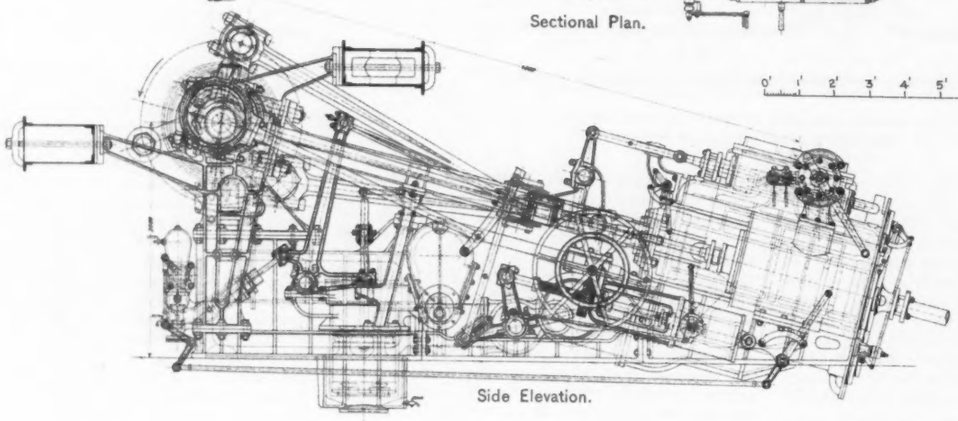
The general dimensions of the vessel are given as follows:

Length on water line	246 ft.
Length over all	256 "
Width at water line	25.1 "
Width over wheel houses	49 "
Depth of hull	8.85"
Draft, loaded	4.6 "
Displacement	527 tons.

Perhaps the most noticeable feature of the deck plans is the peculiar swell about amidships, the overhang of the decks not running nearly continuously around the hull, as is usual in American river steamboats. No explanation is given for this construction by our German contemporary, but it may probably be explained by the fact that this boat does not have the almost continuous row of staterooms around the hull, which is common on American vessels of this type, and, therefore, the overhang, which is something of an annoyance in docking, was not needed except at the wheel-houses. Considering that the vessel has a capacity, it is stated, for 900 passengers, the lack of stateroom and berth accommodations is partic-

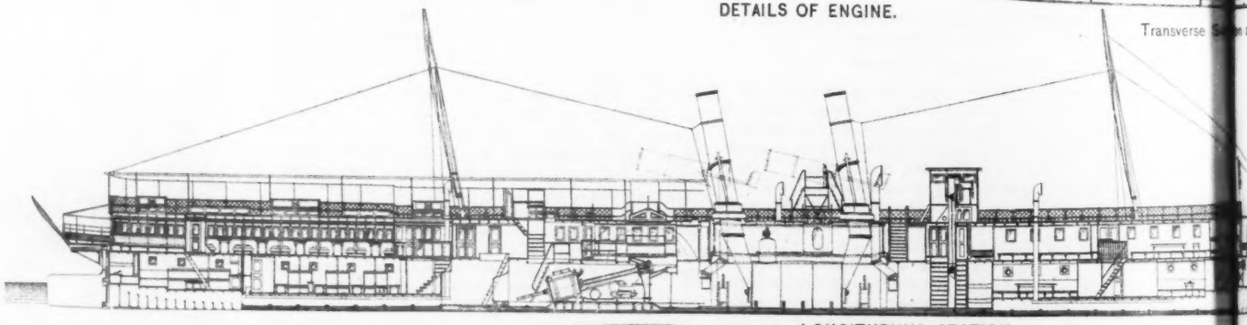


Sectional Plan.

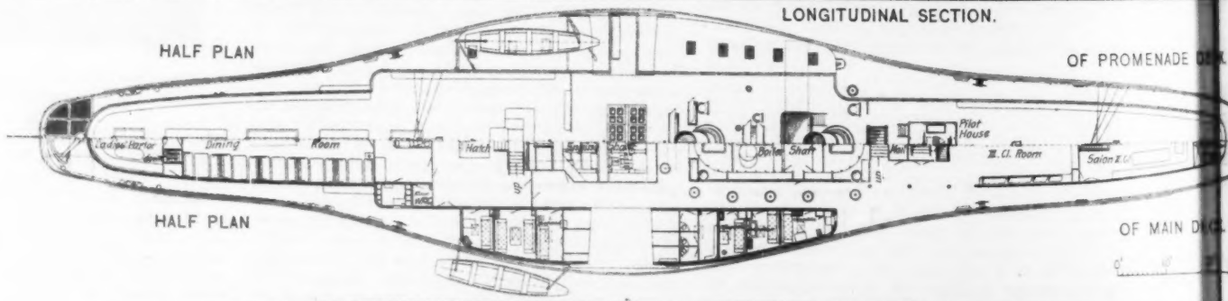


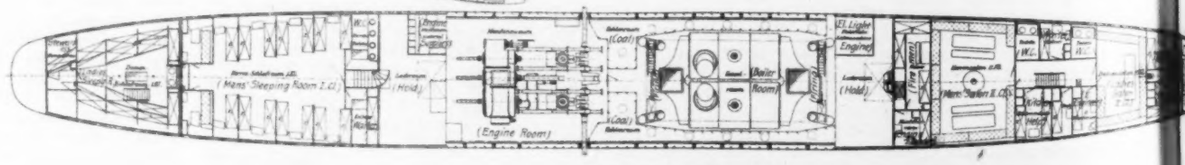
Side Elevation.

DETAILS OF ENGINE.

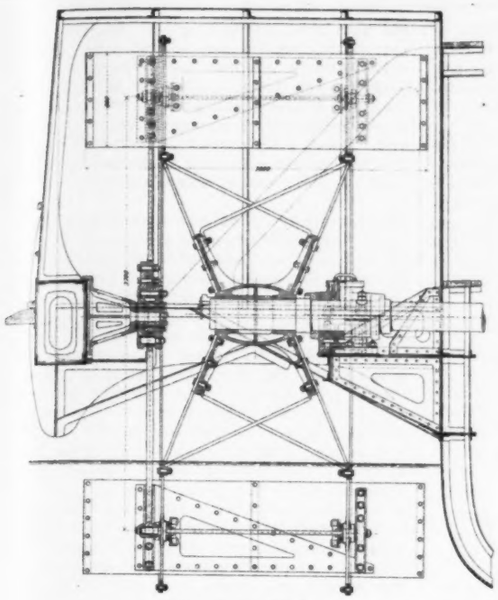


LONGITUDINAL SECTION.

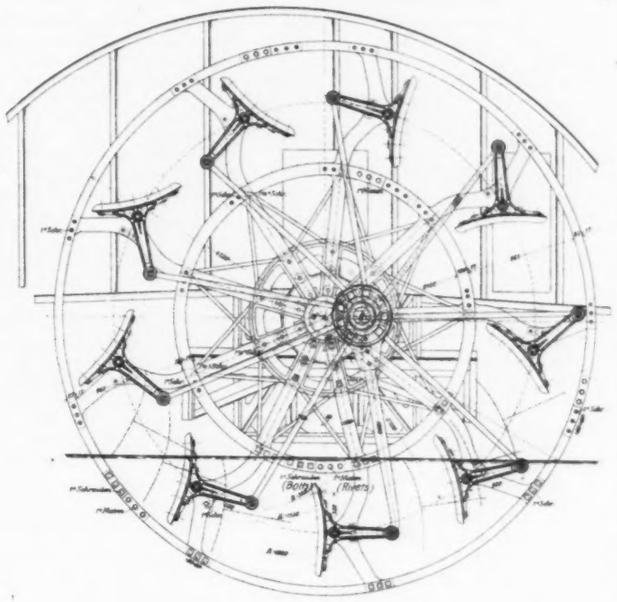




PLAN AT WATER LINE.

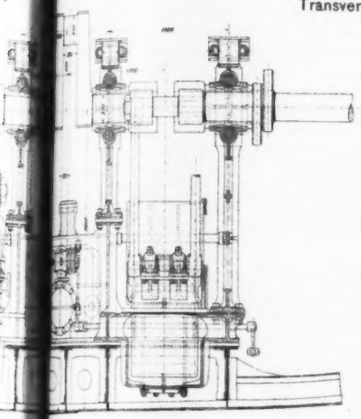


Transverse Section.

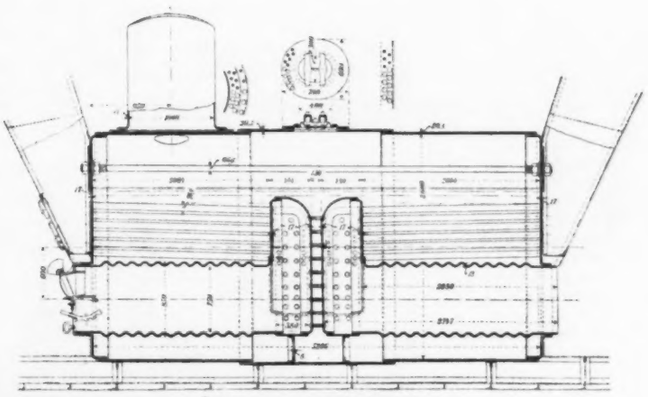


Side Elevation.

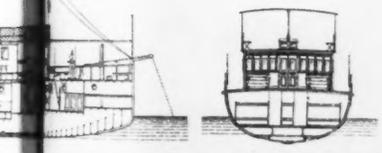
DETAILS OF PADDLE WHEEL.



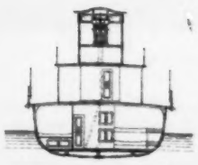
at Paddle Wheel Shaft.



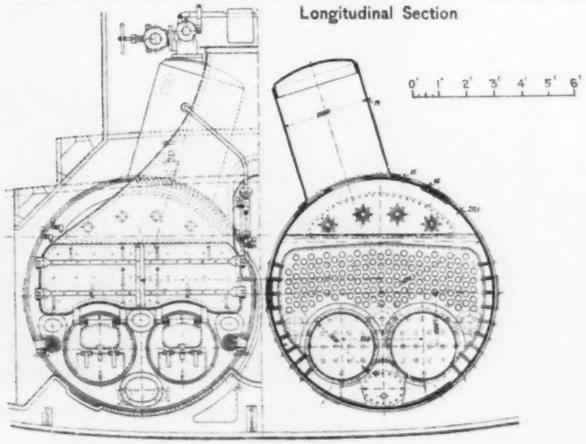
Longitudinal Section



TRANSVERSE SECTION
THROUGH
DINING ROOM.



TRANSVERSE SECTION
THROUGH
PILOT HOUSE.



Sectional End Elevation.

DETAILS OF BOILERS.

DANUBE RIVER SIDE WHEEL STEAMBOAT,
"FRANCIS JOSEPH I."

CHAS. HART & SONS, LITH., 90 VESEY ST., N. Y.

ularly noticeable to the American, but they are probably ample for the mixed crowd of Hungarians, Slavonians, Turks, Jews, etc., which the boat carries, to most of whom a better sleeping-place than the deck is an unnecessary luxury. The arrangement of the passenger accommodations is clearly shown by the various deck plans. The hull and framework of the vessel are built of soft steel and present nothing unusual in their construction.

The plan of the hull and the longitudinal section show very clearly the general arrangement of the machinery, and the design and construction of the boilers, engines and paddle wheels are shown in more detail by the other drawings. The boilers are of the double-ended, interior-fired, flue type, with the steam domes tilting inward. The total heating surface of the boilers is 3,229.3 sq. ft., and they carry a steam pressure of 165 lbs. A boiler feed pump, a donkey pump, and injectors furnish the feed water, four of the feed valves being at the front and two at the rear ends of the boilers. They are also provided with flushing and surface blow-off valves. It will be seen that the corrugated flues at each end of the boiler discharge their gases into a separate combustion chamber, so that the draft in one furnace is independent of that in the one alongside. The flue gases at each end of the twin boilers are conveyed to a separate smoke stack, and these stacks are jointed and counterweighted so that they may be tilted into an approximately horizontal position. The operation of the counterweight is shown quite clearly by the longitudinal section of the vessel. At the base of each stack is a circular cast-iron ring, one-half of which is fixed to the stack and the other half of which is loose on the stack and attached to the counterweight levers, as clearly shown. This loose half of the ring forms the counterweight.

The engine is of the triple expansion, diagonal, paddle wheel type, with an indicated horse power of 840 HP., and works at 45 revolutions per minute. Its main dimensions and details are clearly shown by the drawings. The paddle wheels are of the feathering type known as the Morgan paddle wheel. The paddles, nine for each wheel, are hung by gudgeons from the paddle arm and have their arms connected by rods with a hub or boss running on an eccentric feathering shaft attached to the outer side of the wheel house, as shown by the drawings. It will be noticed that one of the feathering rods is keyed to the boss to give it the required revolution on the eccentric shaft, but the other rods are pivoted both at the boss and at the paddle arms. Each paddle is 9.8 × 2.6 ft. and is strengthened on its back by a triangular piece of steel designed to withstand the torsion resulting when one corner is immersed earlier than the remainder of the area on account of the rolling of the vessel. Each paddle is also strengthened by three stiffening angles fastened to the face, which, it is claimed, also have a tendency to decrease the slip. Some of the other details of the paddle wheels which are of interest are given in a tabular form, as follows:

Diameter at outer ring	15.6 ft.
Diameter at paddle gudgeons	12.1 "
Area of each paddle	26.37 sq. ft.
Aggregate paddle area of both wheels	125.5 "
Area of immersed cross section of hull	108.45 "
Ratio of paddle area to immersed cross section	1.157 to 1
Horizontal forward eccentricity of feathering shaft	12.79 ins.
Vertical upward eccentricity of feathering shaft	0.98 "

On its trial trip this vessel developed a speed of 13.5 miles per hour against the current and 19.4 miles per hour with the current, or an average of 16.4 miles. The specified speed was 15 miles per hour. The coal consumption per horse power per hour was 2.64 lbs. In this respect the vessel also exceeded its specified requirement.

FRENCH SECTIONAL MILITARY BRIDGES AND THE ACCIDENT AT TARBES.

The floods of July 3 having destroyed a masonry bridge over the Adour, on the line of the railway du Midi, in France, the corps of engineers was requested by the railway company to replace the structure temporarily by one of the sectional bridges invented by Commandant Marcille for use in military operations. The bridge was erected, but it fell under a test load on July 17. A commission is still engaged in investigating the cause of the accident; but "Le Genie Civil" meanwhile describes and illustrates the fallen bridge, and from this account the following details are gathered:

These Marcille sectional bridges are built by the Creusot Co. and are stored at various military depots in France ready for immediate use. They are divided into two distinct classes of "large" and "small" bridges; and the "small" bridges are again divided into two groups with spans under 10 m. and spans of from 10 to 20 m. The "large" bridges are also subdivided into spans of 20 to 30 m., and those of 30 to 45 m. spans. In the smaller bridges the railway track is placed upon the top of the girders, while the larger spans may be arranged to carry this track either on the top or upon the lower flange.

The smaller bridges are made by combining sections of plate girders, 10 m., 5 m., 2.5 m. and 1.25 m. in length, as the total span may demand. In the larger bridges the sections are 10 m., 7.5 m., and up to 2.5 m. and 1.66 m. in length. Each of these sections represents a complete element of a bridge; and even those of 10 m. in length, designed for spans of 45 m., do not weigh over 40,000 lbs. and can be readily handled. These bridges are constructed of soft steel, with a resistance to rupture of 64,000 lbs. per sq. in., with an elongation of 20% and an elastic limit of 31,284 lbs. per sq. in.

On account of the purpose for which they are designed these Marcille bridges are made as light as possible; and the 45 m. span type used at Tarbes, where the accident occurred, weighed only 1,475.6 lbs. per lineal foot, including the rails, which were located on the upper flange. The calculations called for a working stress of 14,000 to 17,000 lbs. per sq. in. of section under the test.

As described in "Le Genie Civil," the failing bridge had a span of 45 m., or 147.6 ft., and was made up of sets of plate-girder sections 7.22 ft. deep. These girders were placed 4.92 ft. apart c. to c., with the rails directly over the center-web. They were connected together by cross bracing, and the several sections were united by abutting bolted flanges. The rails were also bolted to shoes carried on the ties laid upon the upper flanges of the two girders. The sections were delivered at the bridge in the order they were to occupy in the finished structure, and they were then bolted together and cover-plates were also bolted in place. The finished girders were rolled out over the space to be spanned, by means of a counterpoised traveler; the rollers and their supports were removed by the use of hydraulic jacks, and the girders were lowered into place upon the piers ready for the ties and rails. The operation of launching these bridges had been previously fully tested at a number of places, with bridges up to 30 m. span, and the military authorities were fully satisfied that the parts could be readily handled and that they suffered no material damage in handling.

WRECK OF A MILITARY BRIDGE ON THE MIDI RY. AT TARBES, FRANCE.

In the case of the bridge over the Adour, the Minister of War issued his orders on July 7, and at 8 p. m. of the same day a train carrying the bridge material and a company of sappers left the depot at Versailles. On July 9, at 7 p. m., the sappers commenced to unload and to assemble the bridge sections; and meanwhile the railway company was building the masonry bridge-seats. The bridge was completed on the morning of July 16, and fell under the regulation tests on July 17. These tests were fixed by a ministerial circular of Aug. 29, 1891, and in this case consisted of two engines and tenders, coupled, followed by two loaded cars. The engines weighed 54 metric tons each and the tenders 18 m. tons each; the loaded cars weighed 16 m. tons each. It is remarked that this load was unequally distributed, as the second engine and its tender, on a base of 15 m., imposed a load of 72 m. tons, or about 4.8 m. tons per lineal metre, while the cars, on the same base, imposed a load of only 2.6 m. tons per lineal metre. "Le Genie Civil" believes this load to have been excessive for a bridge of such a temporary character and much in excess of the load of an ordinary train. The minimum speed prescribed for the test train was 12 miles per hour; but the account does not state whether the bridge failed under the rolling or quiescent load. At the time of the accident, however, the first engine had just passed the center of the bridge.

As far as can be now learned, the masonry abutments of the bridge showed no signs of settlement after the accident, and it has been proved that the bridge was most carefully erected. The failure is thus directly chargeable to the metallic structure itself under the conditions of test imposed. The fallen bridge shows a double flexure in both the horizontal and vertical plan. "Le Genie Civil" discusses the possible effect of unequal expansion in the two girders by reason of the rays of a hot sun, as possibly accounting for an initial horizontal curvature; but finally concludes, with more reason, that the most probable cause of the failure was the extreme lightness of section in the girders under an unusually severe test for a bridge of that type.

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In establishing the office of U. S. Surveyor General in the several states requiring such an official, it was doubtless the original purpose of the government to fill these positions with men of technical education and practical experience in the actual work of surveying public lands, skilled in handling instruments, in making observations and in checking all necessary astronomical calculations. The regulations in force practically requires such proficiency on the part of these officials, if they are to perform the duties they are sworn to fulfil in person and not by proxy. Manifestly the Surveyor-General who lacks this personal and thorough knowledge of the duties of his office and that of his subordinates is simply a place-holder, at the mercy of his clerks. Unfortunately, this office has been frequently made a part of the political spoil of the party in power; and a lawyer or a mere professional politician has too often held a position that can only be properly filled by a thoroughly competent engineer. The evils which result from such a state of affairs have been frequently set forth in these columns and are familiar to every engineer who has had an extended experience with public land surveys.

If the office of Surveyor-General is made a reward for party work by bestowing it upon some leading politician, what is more natural than that he in his turn should select his deputies from those who have been his chief lieutenants in campaign work, regardless of the law which requires that deputies shall be "skilful surveyors." Of the work which such deputies will perform there are, unfortunately, by far too many examples in the records of the Land Office.

If we are correctly informed, under the present administration a determined effort has been made to remedy the evils of past practice in the Land Office, and in the appointments to the office of Surveyor-General thus far made, engineers of education and experience have been selected. Naturally this does not at all suit the politicians, who regard the Surveyor-General's office as a party perquisite, and there have been strong influences brought to bear to induce the appointing powers to name candidates selected by the local party leaders. We sincerely trust that the Washington authorities may stick to their original position and insist that only competent engineers will be considered as candidates for these important positions.

It is not often realized that the surveys made under direction of the Surveyors-General and their deputies establish property boundaries which cannot be altered, no matter how faulty they may be. A few years' defective and dishonest work on the public land surveys in a single state may cause the expenditure of millions of dollars in litigation by property owners.

We are sure that if the responsible officers at Washington understand the importance of this matter they will turn a deaf ear to the appeals of local political leaders, or at the least insist that they shall select competent engineers as their candidates.

The recent bridge accident at Tarbes, France, which we describe elsewhere in this issue, is of interest to American engineers chiefly by reason of the sharp contrast which it furnishes to American methods of dealing with similar situations. According to the account in "Le Genie Civil," the French railway company on whose line the accident occurred, had a masonry arch bridge destroyed by a freshet on July 3. The stream was a small one, the valley through which it flowed was shallow; and had a similar accident happened on an American railway line, it is safe to say that a temporary trestle would have been erected and trains running as usual inside of 24 hours, and this structure would have sufficed until a permanent structure was ready for traffic. This French railway company, however, appealed to the national military engineers to erect one of their temporary military bridges to close the break in its line. As stated above, the washout occurred on July 3. Four days thereafter the Minister of War issued orders for the erection of the military bridge. At 8 p. m. of the same day a train carrying the bridge material and a company of "sappers" left the military depot at Versailles, 500 miles away, and at 7 p. m. the next day began unloading the bridge material at the site of the washout. In the short space of one week, or on July 16, the structure was completed. On the following day it was subjected to the regulation tests, and ignominiously fell under a load of two locomotives weighing, with tenders, 72 metric tons each, followed by two loaded cars weighing 16 tons each.

This remarkable military bridge may be briefly described as a plate girder in sections joined together by bolting. As nearly as we can judge from the engravings, the failure was due to weakness of the cross-bracing between the two girders. The bolted connections had probably lost motion enough to allow the bridge to take a lateral deflection under the test load.

To us, however, the failure of the structure is not so interesting as the remarkable military bridge which requires a week for its erection over a shallow stream less than 150 ft. in width, and the patient railway officials who serenely waited from July 3 to July 17 for the military authorities to close the break in their line. So far as we can learn from the pages of "Le Genie Civil," this opening still remains unclosed. In the view reproduced on another page a temporary trestle can indeed be seen; but it is such a frail structure, entirely without bracing of any sort, that we conclude it was merely for use in constructing the "military" bridge, and that regular trains would by no means be permitted to pass over it.

As far as the efficiency of the military department is concerned, France is not the only country where elaborate and complicated methods have crept into the military establishment, and nothing but the test of actual warfare will probably suffice to root them out. We are reminded by this French incident of an old story of the Civil War, where the commanding general of an army was in haste to cross a large stream to pursue the enemy. The carpenter who had active charge of the work reported at headquarters, and to the query as to how the bridge was progressing, replied: "I don't know whether the officers have got them plans done yet or not, but the bridge is ready."

Considering the important relation which the early history and development of railways in England have borne to the commercial greatness of that country and to the development of the great railway system of the world, it seems somewhat strange that steps were not taken long ago in England to collect and preserve historical papers, drawings, records, locomotives and examples of track and bridge construction, etc., and to establish these in a complete and extensive railway museum. As a matter of fact, few railway companies have kept complete sets of records or drawings of their old structures and engineering works, or have preserved examples of their old types of locomotives, and though many engineers, railway officers, locomotive builders, and others have been willing and desirous to present their individual collections to the nation, there has been no committee or institution to receive such donations and no place in which to store, preserve or exhibit such matter. Individual collections and records, or isolated specimens owned by private parties or business firms, are always liable to be dispersed or lost, and it is therefore all the more important that care should be taken to obtain and preserve them, but it is only within the last year or two that this matter has been given any practical attention or taken up in an energetic manner. The wonderful historical collection in the railway section of the Transportation Department at the Columbian Exhibition in Chicago, in 1893, comprised a great number of valuable records and exhibits donated or sold by English railway companies and locomotive builders, and many additional records of a similar kind have since then been secured by the active representatives of the Field Columbian Museum, of Chicago, for the permanent collection of that museum, the nucleus of which was formed by a selection of the exhibits at the Columbian Exhibition. This extensive presentation of English matter to an American museum has attracted the attention of some influential men interested in the preservation of records and relics of the early history of railways, and the English government has been urged to assist in the founding of a Railway Museum, but so far with little practical effect. The agitation, however, has at last resulted in the formation of a National Railway Museum Committee, the General Secretary of which is Mr. Clement E. Stretton, a civil engineer, who has given considerable attention to this matter and has himself made an extensive personal collection, and who is the author of the well-known book on "The History and Development of the Locomotive." It is to be hoped that something will come out of the present movement, and that the English government will render prompt and effective aid to the proposed National Railway Museum. It is true that in the South Kensington Museum, in London, there are some valuable records and relics (the latter including Stephenson's "Rocket" as rebuilt), but these are only isolated specimens and are not preserved with any care. Until the recent agitation this collection rarely received any additions, but by urgent request of some of the parties interested in the movement, some railway companies are now presenting old locomotives of historical interest and other matter, but meanwhile a vast amount of valuable and interesting matter is being lost, dispersed and destroyed, many historical records being hopelessly lost in the waste-paper basket and the scrap heap. In regard to the Field Columbian Museum, its managers may well heed the lesson indicated by the present experience in England, and bear in mind that much historical matter is being lost and destroyed in this country in the same way as it has been lost and destroyed in England, and this is likely to be found out later on by those who endeavor to look up the details of the history of American railways. While the efforts to secure valuable records and material from abroad are entirely praiseworthy, yet sight should not be lost of the material now available in this country, but which is perhaps liable to be overlooked from the fact of its being so near home, and which may be lost or destroyed as useless old paper and worthless scrap from sheer failure of its owners to realize its importance in relation to railway history.

As an illustration of this we may take the reconstruction of the Victoria Bridge, at Montreal, which is described in another column. The writer of that article suggested to Sir Charles Rivers Wilson, President of the Grand Trunk Ry., that sections of the old tubular spans should be preserved

and presented to certain technical museums and institutions. The answer was to the effect that no steps in this direction had been taken, and that all the old material would be the property of the contractors, but that the suggestion had been referred to the chief engineer, who, however, expresses some surprise at the proposition to preserve full-size sections of the tubes. As full-sized locomotives, cars, steam engines, etc., are already preserved in some institutions, there seems to be no good reason why short pieces of the rectangular tubes, 16 × 20 ft., should not be erected in the grounds or buildings of a museum, and it would certainly be a matter for regret if the entire bridge, which was an engineering wonder in its day, were to be broken up and thrown away as scrap, so that there would be no record of it beyond a few scattered drawings or prints and descriptions.

The Navy Department has lately appointed a special commission of experts to investigate thoroughly and report upon the condition of the government dry docks. This order has doubtless been called out by the mortifying necessity of sending the battleship "Indiana" to a British dockyard for ordinary repairs, simply because this government was without an available dock of the capacity required on the Atlantic coast. It is reported that the late experience with timber docks, at Brooklyn and elsewhere, has influenced the majority of the present board to practically condemn this type of construction for large docks, and that they will favor either stone or concrete construction, or floating docks for this purpose.

It may be safely assumed that the size of a modern dock capable of floating a battleship and the cost of obtaining proper foundations at the points where such docks are most needed will make a recommendation of stone docks quite improbable. The expense would be enormous, and the long time required for construction is another decidedly objectionable point. Concrete has been successfully employed in many foreign docks, and though in a few cases trouble has occurred from the action of sea water on the concrete, the failure has been usually traced to the use of improper hydraulic material, or to bad manipulation of good materials. But the foundation conditions are quite as important for a concrete as they are for a stone dock. Unequal settlement would certainly cause leaks in either case. Floating docks, while claimed to be comparatively cheap, will doubtless prove otherwise when it comes to planning one large enough to float a 12,000-ton battleship; and a sectional dock capable of floating a heavy ship 500 ft. or more long involves not only untried engineering expedients, but also the graver risk to the costly vessel of imposing undue strains, as a result of a shifting of the lines of support from wave action.

The probable result of the present investigation will be the recommendation of a compromise type of construction, or a combination of wood and concrete. The increased use of concrete in government dock construction has already been advocated by the engineers of the Bureau of Yards and Docks, and the recommendation has been put into practice, in part at least, in the Puget Sound dock. Timber is an excellent and cheap material under water and protected from the teredo; and a combination of timber and concrete could doubtless be devised that would form a perfectly stable and tight bottom for the dock. With a proper floor provided, strong enough to resist all lifting tendencies, concrete could be used for the walls and altar supports, and a box could be thus made that would be tight against all emergencies. The chief trouble with the present type of timber dock construction is that dependence, for water tightness, is necessarily placed upon the lines of sheet piling around the floor and about the exterior of the dock. If this sheet piling fails from any one of many causes which the experienced engineer knows are possible, the dock leaks and the cost of repair is a very uncertain quantity owing to the inability to locate and get at the true cause of the failure. The perfect dry-dock is a tight-box, or one that can be made tight by sinking the caisson-gate into its place; the floor of this box must be sunk sufficiently deep below high water to enable a ship of, say, 30 ft. draft to be safely floated into it and this floor must be strong enough to resist the lifting tendency when the dock is empty. In the present type of timber dock construction there is only a reasonably stiff bottom to this box; but the sides, instead of resting upon and forming an integral part of the box, are only represented by two lines of more or less unreliable sheet piling, distinct from the floor, and reinforced by equally uncertain puddling. This construction is cheap and effective under certain conditions, and up to certain limits; but it has proved its insufficiency in recent notable cases. We agree with the present board in their condemnation of the present type of timber dock for heavy ships; but it would certainly appear to be within the possibilities of engineering skill to devise a combination of wood and concrete that would meet the box-conditions of the stone dock and yet be much cheaper and more quickly built.

The use of pin-connected trusses in the reconstruction of the Victoria tubular bridge, as described elsewhere in this issue, is particularly interesting at the present time in connection with the lively discussion of this type of bridge construction now being carried on in the columns of our English contemporaries, "The Engineer" and "Engineering." In this discussion a number of English bridge engineers have been very vigorous in their criticisms of pin-connected bridges; and, deceived doubtless by the fact that riveted connections are more extensively used in American bridge work now than formerly, these English engineers have been rather wildly asserting that pin-connected structures are no longer used in new bridge construction in this country. At this late day we do not need to defend the excellence of American pin-connected bridges when they are properly designed, and it is hardly necessary to deny the foolish statement that they are no longer built. The new Victoria bridge, however, which is illustrated in this issue, is so excellent a rejoinder to the claim that pin-connected construction has been abandoned, that we cannot refrain from calling attention to it. Of all the Canadian railways, the Grand Trunk system is the most thoroughly English in management and policy, and yet for the most costly bridge structure on its lines it is adopting this very American system of construction which the "Engineer's" correspondents are assuring Englishmen has been abandoned, and that to replace a riveted structure built by one of the most famous of English engineers.

In view of this example, it is very funny to read the emphatic assertion of one of "The Engineer's" correspondents that: "There is not now an engineer in England who would design a bridge for heavy railway traffic having pin-connections." Perhaps this may be true; but it does not follow from it that the pin-connected bridge may not be a better structure for long spans. As a matter of fact, English bridge shops are not equipped with machinery for making eye-bars, at least according to American specifications. Unless he is to let the contract to a foreigner, however, an English engineer must stick to the bridge which the English bridge works know how to build.

"The Engineer" devotes a two-column editorial to the subject, in which it blandly sets forth that the reason why Americans employ the pin-connected construction is the same that caused English bridge-builders to use it in the case of "the old Warren girders, which we sent out to India by hundreds of tons in the early railway days in that country." It further condescendingly explains why American engineers still use pin connections as follows:

> The American engineers find it cheaper to build their bridges on the pin principle. They do not consider that circumstances justify them in going to the expense that other nations do for similar structures, and in some measure and in some instances they may be right. The same cause renders their riveted bridges inferior to their pin-connected examples, but it by no means follows as a corollary that our riveted bridges should be inferior to those built by them on the pin system.

In other words, our contemporary solemnly asserts that cheapness is the first consideration in all American bridges; therefore we stick to pin-connections except in a few cases where we try to build a cheap riveted girder and produce a poor structure! Such a statement is too ridiculous to require refutation here. We can only mildly suggest to our contemporary that it should try, if it can, to comprehend the fact that American engineers have no prejudice whatever against any type of bridge construction, absolutely none. They use pin-connections where pin-connections are best, and riveted trusses or girders where that construction is preferable, and never dream of sticking to one type of construction because it is American, or discarding another because it is English. The controversy over the respective merits of rivets and pin-connections which went on two or three decades ago, has absolutely no interest to American bridge engineers of to-day. They know by experience, not theory, what are the excellences and the defects of each type of construction. Their railway bridges have to carry rolling stock far heavier than anything ever known on British railways, and the great rivers that have to be spanned present problems that never occur in Great Britain.

"The Engineer" winds up its lengthy editorial by the remark: "Without disparaging the pin system, we must decline to admit its superiority over our own." Without disparaging the riveted system, we would mildly ask "The Engineer" how it would go to work to erect 400 or 500-ft. riveted trusses over a river in which sudden rises of 20 to 30 ft. are liable to occur at any time? Would not the English engineer think it wise to adopt pin-connections in such a case, even if he had to resort to an American bridge shop to buy the eye-bars?

An error respecting the capacity of the centrifugal drainage pumps built by the New York Dredging Co. for the city of New Orleans, which appeared in the captions of Figs. 10 and 11 in the one-page plate accompanying the article of Mr. J. Richards on "The Design of Centrifugal Pumps," published in our issue of July 29, has been called to our attention by the builders. In the captions the capacity of one of these pumps is given as 19,000 cu. ft. per minute, instead of 9,000 cu. ft. per minute, or 150 cu. ft. per second, as correctly stated in the descriptive text. The discharge of 19,000 cu. ft. given in the caption, it will be seen, is slightly more than the specified capacity of the two pumps, but the builders inform us that this would be about their actual capacity according to the results obtained in the official tests made at a lift of 12 ft. At a lift of somewhat under 12 ft. the pumps gave in the tests a discharge of 200 cu. ft. per second each, which, it is interesting to note, makes them of larger capacity than the Khatabeh, Egypt, drainage pumps referred to by Mr. Richards as the largest in the world. Each of the New Orleans pumps is run by a 400 HP., vertical marine engine, using steam at 180 lbs. pressure in the boilers, and the guarantee on the plant was 1 HP. of water lift per 1¾ lbs. of coal, or 82,500,000 ft. lbs. of duty per 100 lbs. of coal. The engines were of the ordinary marine type, without any refined valve details, as it was rightly considered that with the intermittent load, the interest on the increased cost of higher duty engines would be considerably more than the saving they would make in coal per annum, taking into account the fact that the plant did not run more than 10 per cent. of the time.

Mr. R. C. Strachan has kindly called our attention to a typographical error in his communication printed in our issue of Aug. 19. At the bottom of the first column of page 122 the latter half of the first equation reading: and $P_b = \frac{W}{A} S$, should read: and $P_b = \frac{W}{A} - S$.

GARBAGE AS A FUEL FOR ELECTRIC LIGHT STATIONS.

The recent completion of the garbage disposal works at Shoreditch, London, has attracted a good deal of attention in this country, and more or less has been published in various journals respecting

the perfection of this plant, with incidental remarks concerning the contrast between English and American cities in their conduct of matters of municipal sanitation, etc. The visit of Lord Kelvin to this country has stirred up the matter again, for as soon as he alighted from the steamer and was pounced on by reporters with a request for an interview, he described the Shoreditch plant as the newest thing in sanitary engineering on the other side of the water, and praised it in high terms. If we may believe the reporters, he declared that the Shoreditch precedent was destined to "revolutionize the economic policy of all civilized municipalities," and he advised American cities to go to work at once to utilize their garbage for lighting their streets.

Now Lord Kelvin is almost as well known in this country as abroad, and everyone has the highest respect for his opinions on scientific matters; but sometimes very good scientists make very poor engineers. As a matter of fact, this matter of garbage disposal in connection with steam production has been something of a fad among several great British scientists for several years. The chiefest of these is Prof. Forbes (the same Prof. Forbes who wrote that ludicrously conceited account in an English review of how he designed the Niagara power plant). Prof. Forbes went on record some years ago to the effect that the ash-bin refuse of any population was sufficient to give steam to furnish electric light at the rate of one lamp of 8 c. p. per head for two hours every night of the year. The practical difficulties in the way of accomplishing what is, perhaps, a theoretical possibility were set forth at the time by practical engineers; but in England, as here, there are ten who will read and accept some reckless statement to which a well-known name is attached for every one who will see the proof of the falsity of the statement made by men who are actual and not pseudo-experts in the field.

As a result of "promotion" by Prof. Forbes, Lord Kelvin and some other illustrious and well-intentioned scientists, the schemes for garbage electric lighting stations have had quite a boom in England of late.

As many of our readers are probably aware, systematic methods of garbage disposal are much more common in England than here. It is only recently that American cities have awakened to the importance of disposing of street sweepings, garbage and other refuse in a sanitary matter; but in England, with its crowded population, this matter received attention long ago; and is now well established as a necessary part of the correct sanitation of a community. Cremation is practically the only method in use, and while there are various systems, they all conform closely to one general plan. In probably the majority of English garbage crematories, a steam boiler is arranged to utilize part of the heat passing off from the burning garbage. The steam generated is put to various uses. The most frequent is to supply the steam jets which are frequently used to assist the combustion of the garbage in the "destructors," as they are called. Another common use is to drive grinding mills and mortar mixing machinery. The ash and clinker left after the garbage is burned are ground up and mixed with lime to make mortar, at many of the English garbage furnaces. Of course, the steam is also made use of to drive any other machinery about the works, such as elevators, conveyors, etc.

The possibility of further utilizing the heat from garbage crematories for electric lighting has been agitated for half a dozen years or more; and during the past four years several English cities have established electric light plants in connection with their garbage disposal works. The Shoreditch plant, which has attracted so much attention, is, therefore, by no means the first to generate electric current with garbage as fuel; but it is much the largest installation of this sort thus far undertaken.

As so much is being said concerning this plant and the advisability of American cities copying it, we deem it well to set forth some of the reasons why the success of the plan of generating electric current from garbage crematories is very problematical even in England, and is quite certain to prove a failure if tried in the United States, except possibly under some unusual conditions.

In the first place it must be borne in mind that the primary object of a garbage crematory is to dispose of the refuse that is fed to it in a sanitary manner and without the escape of offensive odors. This must not be interfered with for the sake of producing steam from the plant, or the whole scheme will run risk of public condemnation. For example, at the garbage crematory of Birmingham, England, the boilers were placed immediately over the furnaces for the sake of making more steam. The cool surfaces of the boilers, however, so reduced the temperature of the furnace that complaints of bad odors at once arose. It is well known that in order to destroy odors in a crematory the gases from the burning refuse must be subjected to temperatures so high that the ill-smelling gases will be dissociated. For this reason a steam boiler in a garbage crematory should be placed entirely away from the furnaces.

Again, the use of steam for electric light or other purposes cannot be allowed to interfere with the demands for steam for the steam jets in the furnaces, steam disinfecting, etc. At Oldham, for example, it was found some years ago that 7-16 of the total steam available was used for the steam jets. Possibly substitutes for the steam jets might be developed; but, so far as we know, that has not yet been done.

The most serious difficulty in the use of garbage as fuel for providing electric light is that the garbage is, or should be, burned continuously over the whole 24 hours, whereas an electric light station does nine-tenths of its work in the hours from 5 p. m. to 10 p. m. This difficulty cannot be met by storing the garbage as one would store other fuel; for it is a cardinal principle of success in handling garbage, sewage, and all wastes, that they must not be left to decompose longer than is necessary. Besides this, from the standpoint of economy alone, it would be hopeless to attempt to store garbage. Each furnace must be kept burning day and night, for the garbage cannot be economically burned in any other way. At the Shoreditch station this difficulty is met by Druitt Halpin's heat storage system, which consists briefly in accumulating highly heated water under heavy pressure in huge cylindrical tanks. The great expense of this system is the chief objection to its use.

The Halpin heat storage system can, if put in on a large enough scale, take care of variations in the heat produced during the 24 hours; but it cannot provide for variations of another class. Experience shows that the fuel value of garbage, and its amount as well, varies between very wide limits, not only from hour to hour and day to day, but in different seasons, and there is a wide difference in the garbage from different towns.

In the winter season, for example, the proportion of ash and unburned coal will be much larger than in summer when household fires are few. In the season of green vegetables, melons, etc., the amount of garbage collected will be large; but it will have a larger percentage of water than usual. Electric light station managers are not wholly unacquainted with troubles arising from variations in quality in coal; they can readily understand, therefore, that with a fuel whose calorific value is at best only about one-tenth as great as that of coal, a falling-off in quality means a serious reduction in the heating power.

Good evidence of the great variation in the calorific power of town refuse is afforded by the results of investigations which have been made of the results obtained in burning garbage in different English cities. For example, in a list of a dozen cities the water evaporated in the boiler per pound of refuse burned ran from ¼ lb. to 1¾ lbs. Lord Kelvin, in published interviews, declared that garbage had on the average one-tenth the calorific value of coal; but Mr. Thos. Tomlinson, Assoc. M. Inst. C. E., as a result of an exhaustive investigation, concluded that, under practical conditions, 500 to 800 lbs. of water evaporated per ton of garbage burned was as much as could reasonably be expected. This value, it will be seen, is only a half to a third of what Lord Kelvin claimed, but its correctness is attested by such authorities as Mr. Bennett, the engineer in charge of the Southampton disposal works, who states that 60 lbs. of refuse burned per I. HP. per hour is the best result he has been able to obtain.

These figures, it must be understood, apply solely to Great Britain, and there is reason to believe that the calorific value of the refuse in American cities averages much lower than this. So far as we recall, most American garbage crematories use more or less fuel in connection with the garbage to keep the temperature at the requisite height. Prof. Forbes some years ago stated that Paddington ash-bin refuse contained on an average 29 per cent. of cinders or breeze, and the quantity of cinders was more than half as large as the quantity of ashes. The explanation of this high percentage of unconsumed coal is doubtless found in the almost universal use of soft coal and open grate fires. In the United States, where stoves or furnaces are the rule for house heating, and especially where anthracite is the fuel used, no such large quantity of unconsumed coal could be found, we believe.

In view of this fact alone, Lord Kelvin's announcement that the Shoreditch station is destined to "revolutionize the economic policy of all civilized municipalities" seems a trifle premature. It may be that a British city can light a few streets by a dynamo at its garbage furnaces at a profit; but the electric light station in the United States which should attempt to use garbage as fuel in the watermelon season would be apt to leave its patrons in darkness.

In the enthusiasm with which the proposal to burn garbage in electric lighting plants has been received, there seems to be danger of forgetting that the question is, after all, the simple old question: Will it pay? Let it be remembered that the fuel is only one item in the cost of generating electric light, and by no means the largest one. The fuel bill in the average electric lighting station in this country is only from 10% to 30% of the total cost of the current delivered to the consumer. In order to save this per cent. will it pay to locate the electric light station where the garbage works may be? Let it be remembered that a central location is generally considered an economic necessity for an electric light plant, while a location in the outskirts is almost always chosen for a garbage disposal plant. Will it pay to invest in great steel storage tanks to accumulate heat during the hours when light is not needed, or to charge storage batteries for use when light is called for?

We do not say it will not pay anywhere under any possible conditions; we merely point out that under the average conditions it looks very much as if the attempt to utilize garbage as a fuel for electric light production would result in no economy, even in England, and could hold out no prospect of success if tried in this country.

We have deemed it well to give considerable space to this matter; for we doubt not some of our readers will have Lord Kelvin and Prof. Forbes quoted to them as authorities on garbage disposal, and will wish to be posted on the real state of affairs.

The subject of garbage disposal is still in so unsettled a state in this country that cranky ideas on the subject are all the time cropping up and receive a cordial welcome. For example, one Dr. Reilly, Assistant Commissioner of Health, of Chicago, has seriously proposed to place a "garbage dryer" in the chimney of each pumping station of the city water-works and each electric light and power station, and place the garbage in it as collected. It is unnecessary to tell any engineer familiar with the first principles of garbage disposal what the result of this would be; but for the benefit of the unoffending citizens of Chicago we may suggest that the odor from each of these garbage frying pans, located in the heart of the city, would discount the worst smells that ever proceeded from the packing-house district or the malodorous South Branch. Should Chicago ever try this scheme, we venture to predict that the indignant citizens would cremate Dr. Reilly in one of his own frying pans.

LETTERS TO THE EDITOR.

Tension of Spokes in Bicycle Wheels.

Sir: We have read with interest an article in your valuable journal of Aug. 12, taking up the matter of tension of spokes in bicycle wheels, by Prof. D. W. Hering. The subject as a whole is well treated, but, as manu-

facturers of high grade bicycles, we wish to take exception to some of the remarks. Your correspondent makes the statement that no improvements have been made in the manner of constructing suspension wheels. Four years ago we recognized the necessity of improvement in this direction, and at once set to work devising appliances to overcome the objections of unequal tension. In this we have been entirely successful, for any rider of an "Orient" bicycle will bear witness to the fact that broken spokes and untrue wheels with them are unknown.

The Professor is also in error as to the advantage derived by the use of tangent spokes, claiming that the mode of attachment only is superior. As a matter of fact, this same mode of attachment may be applied to direct or radial spokes as well as tangent. The real advantage derived is the greater resistance offered by the spokes against the torsional pull of the chain on the rear hub. This element does not seem to be taken into consideration at all by Prof. Hering in calculating the stress on the spokes. Without going into detail we may venture to say that this element has more to do with broken spokes than the matter of the rider's weight.

In regard to the suspension of the hub by successive groups of four spokes, it is our opinion that this suspension is supported at all times by one-half of the number of spokes contained in the wheel. To be sure, this strain is constantly shifting according to the progress of the wheel, and varies according to the relative positions of the spokes, but, taking the wheel shown by the illustration in your issue of Aug. 12 at rest, with spokes Nos. 36 and 1 perpendicular; the strain would be resisted in pairs or groups from 36 to 28 and 1 to 9, inclusive. In support of this theory let us suppose all of the spokes from 24 to 36—and 1 to 8 inclusive, are removed; then assuming the rim of sufficient strength to withstand the strain, the spokes 28 and 9 would receive the entire stress, by adding the missing ones the stress on each would be diminished according to location.

The safety point in the construction of a suspension wheel is the point at which it will stand legitimate use on rough roads without breakage or warp. It is useless to try to guard against accident, for that may vary from the malicious boy's hoop stick to a fire engine or trolley car. Yours truly,

Waltham Manufacturing Co.,
Chas. H. Metz, President.

Waltham, Mass., Aug. 23, 1897.

NOTES OF A CANADIAN JOURNEY.

In June and July the writer went from New York to Quebec, to attend the annual convention of the American Society of Civil Engineers, and from Quebec proceeded to Halifax, and thence to Montreal and Chicago, and up to Duluth to attend a meeting of the American Institute of Mining Engineers. The following article contains notes of things seen and information collected during that trip, the proceedings of the meetings at Quebec and Duluth having already been reported in our issues of July 8 and 22.

Quebec.

This is perhaps the most interesting city on the North American continent from an historical and antiquarian point of view, since it is essentially an ancient city which has not been rebuilt and not very much invaded by modern ideas. Here are the old French buildings of massive stone construction, and the language and customs of the "habitans." In the upper town is the great fortress, and the city itself is a walled city, the ramparts extending across the heights of the narrow peninsula upon which the city is built, and having fortified gateways over the three principal streets which extend into the country. The St. Louis gate and Kent gate have been reconstructed on modern plans, and have each a wide single arch over the roadway. The St. John's gate is of older construction, and is of massive masonry pierced by three archways, but this is to be removed in consequence of the obstruction to traffic, and bids for the work have recently been received by Mr. Charles Baillairge, the City Engineer. The garrison is composed of colonial troops. The city has a handsome modern City Hall, built of stone, in the council chamber of which were held the meetings of the American Society of Civil Engineers at its recent convention.

The city has for some years had a small horse car line, but the Quebec District Ry. Co. is now laying tracks and putting up trolley wires for an electric railway, the current for which will be transmitted from the power station at the Montmorency Falls, seven miles from the city. This seems a rather harsh innovation in a city like Quebec, where the galloping and bounding "calèche" still holds its own in spite of the introduction of the modern hack. The railway company proposes to build a steel trestle up Palais Hill to reduce the grade, and the city authorities have approved this, conditionally upon the government granting the use of the land required.

Quebec Harbor.

The city is a seaport of some prominence, having an extensive river and coasting trade, while ocean steamers also sail from here, and nearly all the ocean mail steamers to and from Montreal make Quebec a port of call. During 1896 there were 356 vessels entered inward and 294 outward, the imports amounting to $4,013,903 and the exports to $5,411,418. Mr. J. B. Laliberte is Chairman of the Harbor Commissioners, and Mr. St. George Boswell, M. Inst. C. E., is Chief Engineer.

The principal artificial works of the harbor are those of the Princess Louise docks and embankment, opened in May, 1890. As shown by the accompanying plan, Fig. 1, these works are situated at the junction of the St. Charles and St. Lawrence rivers. The outer or tidal basin has an area of about 20 acres, and a general depth of 26 to 27 ft. at low tide, with a quay frontage of 2,860 ft. Along the face of the embankment quay there is a depth of 24 ft. of water, but a vessel lying 10 ft. from the quay can have a depth of 26 ft. of water. Spring tides rise 18 ft. and neap tides 12 ft., the average rise of tides being 15 ft., but as the tide rarely falls to within 1½ ft. of the low water datum, the depth of water in the tidal basin is virtually greater than that given above. The inner dock, or wet dock, has a water area of about 40 acres, a general depth of water of 27 ft., and a quay frontage of 3,700 ft. The dock gates are open twice in 24 hours, for a period of about two hours each time. The entrance lock is 66 ft. wide, and is closed by a set of timber miter gates, the depth of water on the sill being 18 ft. at low tide, and about 20 ft. at high water of neap tides. The entrance is crossed by a steel high-way bridge, which runs back and forth on two double tracks, the time for opening or closing being about 45 seconds. It is operated by steam. The embankment is about 4,000 ft. long and 330 ft. wide, and the cross wall 800 ft. long and 150 ft. wide. On the embankment are railway tracks connecting with the several railways entering Quebec. The quay walls of the dock, below low water, consist of crib work, the front pockets of which are filled with concrete laid in a plastic state. The superstructure is in some cases entirely of masonry, while in others it is of concrete with a facing of cut stone. A watertight clay wall and an intercepting sewer have been carried along St. Andrew St. for the purpose of preventing leakage through the made ground along the south side of the docks, and for intercepting the sewers formerly discharging into this part of the harbor. The sewer is of masonry, 6×8 ft., and discharges off the Custom House wharf.

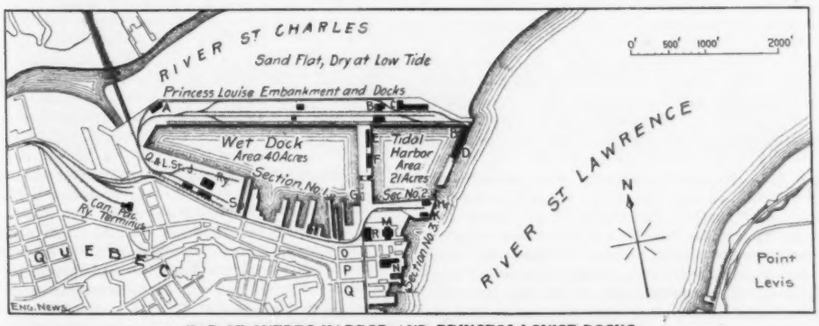
The docks are provided with grain elevators, freight sheds, and a cold storage building, the cold dry air circulation system being used. No coal is loaded at these docks, but a large quantity, both of hard and soft coal, is received, special portions of the embankment being set aside for coal cargoes. Particulars as to the construction of the Louise Docks and Graving Dock will be found in Vol. I., Part 2, of the Transactions of the Canadian Society of Civil Engineers.

The works now under construction and contemplated consist of completing the quay walls along the south side of the wet dock and tidal harbor; the construction of a quay wall 1,100 ft. long along the river front, from the Point-a-Carcy wharf in a southerly direction; the construction of a graving dock about 700 ft. long, and the erection of double-deck freight sheds provided with hydraulic or electric wharf cranes and other freight handling machinery. The quay walls under construction and contemplated are shown by heavy dotted lines on the accompanying plan, Fig. 1, and are marked Sections Nos. 1, 2 and 3. Section No. 2 is now about complete and has cost $83,000; this gives a quay frontage of 600 ft. on the south side of the tidal dock, with a depth of 30 ft. at low water spring tides; this quay wall is constructed of crib work, 54 ft. high and 40 ft. wide at base, stepped off to 18 ft. at coping; the filling is of stone, no concrete having been used. Section No. 1 will be 2,800 ft. long, and is to be constructed of cribwork of the same form as adopted for Section No. 2, and is estimated to cost complete $400,000. Section No. 3 is a deep water quay wall extending along the river front for 1,100 ft.; estimated cost (if in cribwork), $360,000.

A new graving dock or dry dock on the Quebec side of the river is proposed, and the site suggested for this dock is at Point-a-Pijean, about three miles south of the entrance to the Louise Docks. The dock is to be 700 ft. long, with an entrance 80 ft. wide, and a depth of water of 28 ft. on the sill at average high tide. The dock is to be of masonry and concrete and the estimated cost is $700,000.

Opposite Quebec is Levis, or Point Levis, where are situated the stations and yards of the Intercolonial and Grand Trunk railways, a stone dry dock, and the works of Carrier, Laine & Co., manufacturers of dredging plant, cranes, and other machinery. The dry dock was formerly under the control of the Quebec Harbor Commissioners, but now of the Dominion Government, but the Commissioners have petitioned the Minister of Public Works to restore to them the management of this dock.

The dry dock or graving dock at Point Levis is constructed of masonry and Portland cement concrete. It is rectangular with a semicircular head of 31 ft. radius, the total length from caisson to circular head being 484 ft. The entrance is closed by a caisson which moves on rollers and is withdrawn into a covered recess when the dock is being opened. The caisson is provided with a watertight deck and automatic valves, so arranged as to keep the flotation constant. The dock was opened in 1886 and the engineer states that it has since withstood the climatic influences without injury from frost, notwithstanding the claims of the advocates of timber dry docks. The



MAP OF QUEBEC HARBOR AND PRINCESS LOUISE DOCKS.

(A) Coal-oil store. (B) Grain elevator. (C) Immigration building. (D) Disinfecting building. (E and F) Freight sheds. (H) Warehouses. (K) Cold store. (M) Custom house. (R) Harbor Commissioners' offices. (N) G. T. Ry. (O) Bank of Montreal. (P) Bank of B. N. America. (Q) Quebec Bank. (S) Terminus Q. & L. St. J., Q. M. & C., and B. L. Rys.

dimensions of the Levis dry dock and the proposed Quebec dry dock are as follows:

	Dry Dock Levis.	Proposed Dry Dock Quebec.
Length of dock on floor (inside sill)	484 ft.	700 ft.
Width of dock at floor	60 ft.	....
Width of dock at top	100 ft.	....
Depth of dock from coping to floor	34 ft.	39 ft.
Depth on sill	32½ ft.	37½ ft.
Width of entrance lock	62 ft.	80 ft.
Capacity of pumps, gals. per min.	14,000	....
Time for emptying dock	3 hours.	....
Style of pumps used	2 barrel pumps. 4 ft. diam × 5 ft. stroke.	....
Number and style of boilers	3 tubular, 14 × 6 ft.	....

Railways of Quebec.

The Province of Quebec has a number of railways, of which the following are the most important:

(1.) The Canadian Pacific Ry.; this has a line on the north side of the river from Montreal to Quebec, 172 miles, and a line from Montreal to St. John, N. B., 481 miles, which latter line cuts diagonally across the Province and crosses the state of Maine. (2.) Grand Trunk Ry.; this has a line from Montreal along the south shore to Levis, opposite Quebec, 173 miles. The Halifax sleeping cars of the Intercolonial Ry. are hauled to and from Montreal over this line. There is also the main line south from Montreal to Portland, Me., 297 miles. (3.) Intercolonial Ry.; this is the line built and owned by the Dominion Government, and extends from Levis to Halifax, 678 miles. Some notes on each of these three lines will be found farther on. (4.) Quebec Central Ry.; this extends from Levis, opposite Quebec, to Sherbrooke, 143 miles, and gives through connections to New York and points in New England. (5.) Drummond County Ry.; the main line now extends from Ste. Rosalie Junction (Grand Trunk Ry. and Canadian Pacific Ry.) to Forestdale, 66 miles, but an extension of 43 miles is now under construction from Forestdale, the present terminus, eastward to Chaudiere Junction, at which latter point it will connect with the Intercolonial Ry., Quebec Central Ry. and Grand Trunk Ry. Ste. Rosalie is 38 miles from Montreal and access to that city is obtained by running over the Atlantic Division of the Grand Trunk Ry., from St. Hyacinthe. The new line is already connected with the I. C. Ry. and G. T. Ry. at Chaudiere, and track is being laid from both ends and from the middle of the line, material being taken down over the Lotbiniere & Megantic Ry., which extends from Lyster on the G. T. Ry., north to St. Jean on the St. Lawrence River, and which is crossed by the new extension. The construction of this extension was commenced last spring and is expected to be completed by November, 1897. The Dominion Government proposes to utilize this line as an extension from Levis to Montreal, leasing it for 9 months as an experiment, and then leasing it for 99 years. The line is built to meet the government requirements and the track is laid with 70-lb. rails. Mr. W. Mitchell, General Manager, states that the traffic is mainly in general merchandise, forest products, butter and cheese and other agricultural produce. The company is doing its own construction and had about 700 men at work in July. (6.) Quebec & Lake St. John Ry.; this line extends from Quebec north to the hunting and fishing regions and the summer resorts at the head of the Saguenay River. At the upper end the line forks, one part going to Roberval, 190 miles, where there is a large hotel, and the other going down the river to Chicoutimi, 228 miles, where connection is made with the Quebec steamers of the Richelieu & Ontario Navigation Co., so that a round trip by rail and boat may be effected. The Quebec end of this line, and the Lower Laurentian Ry., which branches off from it (and is leased by the Q. & L. St. J. Ry.), will form the eastern connection of the Great Northern Ry. of Canada. (7.) Great Northern Ry. of Canada; this line is at present but 38 miles long, but it is intended to extend it to form a direct connection between Quebec and Parry Sound, a distance of 550 miles. The eastern link, from Montcalm to Grand Mere, 55 miles, is now being built. The western link will be from St. Jerome to Grenville, on the Ottawa River, and a bridge will be thrown across the river from Grenville to Hawkesbury, on the Canada Atlantic Ry. This line would open up a great timber country and possibly some mineral districts. The Q. & L. St. J. Ry. is interested in this project. It is reported that if the proposed bridge over the St. Lawrence at Quebec should be built, connection may be made between this line and one now under construction from the Baie des Chaleurs, on the Atlantic coast. (8.) Quebec, Montmorency & Charlevoix Ry.; this line has now been extended nine miles beyond Ste. Anne de Beaupre to Cape Torment, 30 miles from Quebec. Its charter is for a line along the north shore as far as Murray Bay, but there is no prospect of the road being built to that place just now. The company has no terminal station proper in Quebec, but its line terminates beside a little wooden shanty, the passengers being landed on the wharf at the side of the street. The brick station of the Quebec & Lake St. John Ry., a little farther up the street, was built for a union station, as both lines use the same tracks to and across the St. Charles River bridge, but the charge made by the Q. & L. St. J. Ry. Co. was higher than the other company cared to pay. It was intended to build a station on the site of the present shanty, but so far nothing has been done to carry this into effect. Now that the water power of the Montmorency Falls has been utilized to develop electric current which is transmitted to Quebec for lighting purposes and for operating the new electric railway, it is considered probable that eventually this line will be operated by electricity. If that is done it will be interesting to see how the very heavy traffic of pilgrims to the shrine of Ste. Anne will be handled, as it is now carried in trains of 12 to 15 cars, 10 to 20 trains a day.

Grand Trunk Ry.

The striking and distinctive appearance of the red painted locomotives formerly significant of this line is now missing, the old familiar color having given place to black paint, planished iron and aluminum-leaf paint, while the red of the cars has been replaced by Pullman brown. This is evidently due to the influence of the new management, composed largely of officers from American railways, but in view of recent investigations it is questionable whether the change from painted boiler jackets to planished-iron jackets is a good one from an economical point of view. In the tenders and passenger cars there is still the noticeable feature of the general use of spoke wheels, with tires secured by Mansell retaining rings. The yards and shops at Toronto are exceptionally neat and well kept, the buildings being clean and in good condition, scrap neatly sorted and piled, and a general appearance of care and good management pervading the place.

A most important change which is now being prepared for, is the substitution of truss spans for the tubular spans of the celebrated Victoria bridge over the St. Lawrence. This structure is one of the celebrated bridges of the world, and was designed by and built under the supervision of Robert Stephenson, to give the old Grand Trunk Ry. line from Portland, Me., an entrance to Montreal. It has 25 spans, all of rectangular tubular construction, carrying a single track. Extensive repairs to the floor have been required during recent years on account of corrosion from rust and the brine dripping from refrigerator cars, while the foulness of the air within this iron tunnel, and the consequent corrosion, have led to the opening of a strip of plating along the middle of the roof, the roof being reinforced by angle irons riveted along each side of the opening. The new bridge, designed by Mr. Joseph Hobson, Chief Engineer of the Grand Trunk Ry., will be for railway, electric railway and vehicular traffic, the electric cars and steam trains running on the same tracks. The work of lengthening and repairing the masonry piers has already been commenced, and contracts for the spans have been let to the Dominion Bridge Works, of Montreal (6 spans), and the Detroit Bridge & Iron Works, of Detroit, Mich. (19 spans and the erection of all the spans), while a subcontract for nine of the spans has been let to the Union Bridge Co., of New York. The new structure, which will be styled the Victoria Jubilee bridge, is illustrated and described on another page of this issue.

Intercolonial Railway.

This road was built by, and is now still operated by, the Dominion Government, being the only line which is now thus owned and operated, although the Government has had at various times other lines which it has built and operated, but which it has gradually disposed of to private railway companies. The main line extends from Levis (opsite Quebec) to Halifax, N. S., 678 miles, with a line from Moncton to St. John, N. B., 89 miles. At Halifax there is a handsome brick terminal station, with trainshed, which is used also by the Dominion Atlantic Ry., whose trains run over the Intercolonial Ry. tracks as far as Windsor Junction, 14 miles. There is also a well-built freight station. The railway has extensive terminal facilities at Richmond, one mile outside of Halifax, but during the past two years it has extended two miles into the city and constructed an extensive deep water terminal at a cost of $350,000, the work including 1,900 creosoted piles of Virginia shortleaf pine, with upper works of Georgia longleaf pine Mr. Wm. B. McKenzie, Assistant Chief Engineer, states that here the largest ocean steamers can load or unload and take in bunker coal by overhead chutes at the same time. The area of the land, wharves and docks is 6½ acres, and the yard covers 9½ acres, while the sidings aggregate 3¾ miles. The wharves have an area of 92,600 sq. ft., and the buildings cover 94,068 sq. ft. These buildings include a brick freight house, 765 ft. long, with slate roof on iron trusses; also a new immigration building, built by Rhodes, Curry & Co., of Amherst, which was completed in December, 1896. It is one and two stories high, fitted with hot-water heating apparatus, electric light, fire-protection plant, and a fumigating apparatus. In 1895 destructive fires occurred at the Richmond and deep-water terminals, destroying wharves and freight houses to the value of $87,000 at the former and grain elevators, wharves and freight houses to the value of $200,000 at the latter. The causes of the fires were never definitely ascertained.

The Quebec end affords no good facilities for traffic, since it terminates at a ferry opposite the city, and passengers and freight have to be transferred by ferry, as noted above in connection with the proposed Quebec bridge. Through cars to Montreal are run from Levis over the Grand Trunk Ry., but in order to make the line more independent in operation, it is proposed to enter into an arrangement with the new Drummond County Ry., which is now building an extension from its present line to connect with the Intercolonial Ry. at Chaudiere. The proposition is to make a contract for nine months or a year as an experiment, and if this proves satisfactory, to lease the road for a term of 99 years at an annual rental of $64,000. The Government will pay separate rental for an entrance to Montreal over the Grand Trunk Ry., making a total rental of $210,000 per year for the through connection from Chaudiere Junction to Montreal. The Intercolonial Ry. has always been controlled more or less as a political machine, and its operation has always led to an annual deficit, but there are indications that attempts are to be made to operate it upon a more commercial basis. Among the improvements proposed are the Montreal extension, the establishment of a refrigerator car service, and the obtaining of more favorable traffic conditions from St. John by cutting down the privileges which the Government has granted to the Canadian Pacific Ry., and which now give that latter line great advantages over the Government's own line.

The road is well built and equipped and the Government operates its own sleeping car service. The train from Quebec consisted of two baggage and express cars, one colonists' sleeping car, two day cars, one sleeping car for Halifax, and one sleeping car for St. John. The latter car is cut off at Moncton, and the car from St. John to Halifax attached in its place. All the cars have an outer sheathing of vertical strips of redwood, varnished but not painted, as is the practice on the Canadian Pacific Ry. The through sleeping cars between Montreal, Levis and Halifax are lighted by incandescent lamps, the electric current being supplied by storage batteries contained in two boxes under the middle of the car, the batteries being sufficient for the round trip, and being changed at Halifax. These cars are very well built and equipped, and were built at the works of James Cyssen, of Coburg, Ontario.

Halifax, N. S.

Halifax is an important town and a seaport with a magnificent land-locked harbor well protected by fortifications at the entrance. During the American civil war it was a very busy place, being (like St. Thomas, in the West Indies) a headquarters for blockade runners. Its trade is considerably increased in the winter, after the ice has closed the St. Lawrence, as it is then the winter port for steamship lines running to Montreal. Besides the fortifications at the entrance to the harbor, there are fortifications and the citadel above the city, intended for defence from land attacks. The citadel has fairly extensive works, but the largest guns are 7.2-in. muzzle-loading rifles. The equipment includes a Watkins range-finder. The troops here are "imperial," or British troops, while the garrison at Quebec is composed of colonial troops.

There is but little municipal work in progress, but the city engineer, Mr. F. W. Doane, has a little of everything to look after, including the buildings and grounds of the new provincial exhibition, established by the government. The streets along the hillsides have the slope of the hill at the intersections of cross streets, but an endeavor is being made to change this, though there is some difficulty in establishing the change of grade of sidewalks. The jurisdiction of the municipal authorities extends to low water mark, the piers, wharves, etc., of the harbor being under the control of the provincial government. A garbage collection system is now in force, and was described in our issue of Aug. 19. At first a triple separation and classification of the garbage was compulsory, but there was such an objection made to this that it is now only required to be separated into two classes, which are kept in separate receptacles. The garbage is taken by the contractors' wagons and dumped into low spots beyond the settled portion of the city, being then covered with cinders and gravel. A garbage cremation plant has been suggested, but the city authorities would not listen to the proposition. The City Hall is a handsome structure facing on the Parade, and there is a large building for the Post Office and Custom House, but the Provincial Government Building and governor's residence are sombre and unpretentious structures.

There is a royal dockyard, and also a dry-dock which is owned by a company having a subsidy from the government. In the dry-dock, at the time of the writer's visit, was the grain steamer "Knight Bachelor," whose bows had been stove in by collision with an iceberg in the Atlantic on April 26. The vessel was of 4,130 tons net register, with a cargo capacity of 9,300 tons, but had, fortunately, water ballast only at the time of the accident. The steel plates and frames were bent and doubled up in a very remarkable way, giving evidence of great ductility in the metal. The repairs are being made by the Halifax Dry-Dock Co., the plates, etc., being sent out by the builders, Messrs. Connel, of Glasgow.

Dominion Atlantic Ry.

This line extends from Halifax across Nova Scotia to Digby (where steamer connection is made for St. John, N. B.) and then westward along the coast to Yarmouth, where connection is made with steamer lines to Boston. This line passes through the land of the Acadians, and has a station at Grand Pre, the site of the old French village immortalized in Longfellow's "Evangeline." On this basis the company has within the past two or three years been developing a large tourist traffic to "Evangeline's land." At a factory near Windsor one notices a cooling apparatus for condensing water; the water is led down a long horizontal pipe with apertures in the sides, through which the water spurts and falls on an inclined table of planking, along the lower edge of which is a collecting conduit. The locomotives are painted red, of a somewhat lighter shade than that formerly used on the Grand Trunk Ry. At Digby the train runs out on a pier alongside the company's fast side wheel steamer "Prince Rupert" for St. John, crossing the Bay of Fundy, with its 60-ft. tides. Owing to the great height of the tides (40 to 60 ft.) the water pours in through Digby Gut, the narrow entrance to the land-locked harbor, like a rapid, the water boiling up as it does in the still water between the falls and the rapids at Niagara. The steamer and its engines were built on the Clyde in 1894 by Denny Brothers, of Dumbarton, Scotland, and came out across the Atlantic under its own steam. It has feathering wheels, driven by a triple-expansion engine, the cylinders being all on one side of the shaft and inclined upwards to it. Steam is supplied by two Scotch marine boilers. The leading dimensions are as follows, as furnished by Mr. P. S. Gifkins, Passenger Traffic Superintendent of the D. A. Ry.:

Steamer "Prince Rupert."

Length over all	270 ft.
Beam	30 "
Depth of hull	10 ft. 6 ins.
Draft, loaded	10 " 6 "
Displacement on mean draft	1,400 tons.
Speed, average	21 miles.
Cylinders, diameter	31½, 47 and 68 ins.
Cylinders, stroke	6 ft.
Forced draft system	Closed stokehold.
Boiler heating surface, total	7,300 sq. ft.
Grate area	175 sq. ft.
Boiler pressure	160 lbs.
Wheels, diameter	17 ft. 6 ins.
Number of buckets	Seven.
Size of buckets	15 ft. 6 ins. long, 4 ft. 6 ins. deep.
Engine revolutions at normal speed	54
Freight capacity of hold	100 tons.
Number of passengers	850

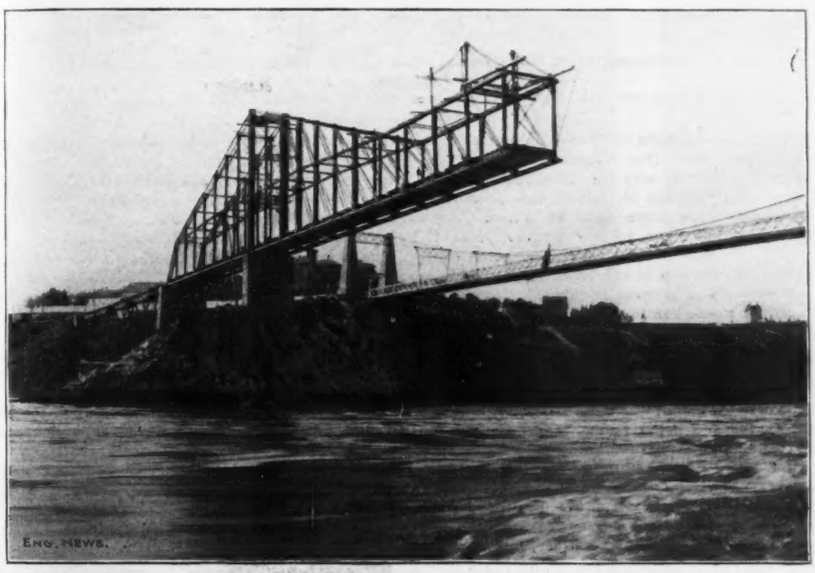


FIG. 2.—CONSTRUCTION OF THE WEST SIDE OF THE CANTILEVER RAILWAY BRIDGE AT ST. JOHN, N. B., 188
Dominion Bridge Co., Builders.

Canadian Pacific Ry.

This railway has now its own line from the Atlantic port of St. John, N. B., to the Pacific port of Vancouver, B. C., with a main line mileage of 3,387 miles. The line from St. John to Montreal, 481 miles, is partly over the old New Brunswick Government Ry., then over a part of the Maine Central R. R. (to Mattawamkeag), and then over the company's own line, passing through a wild country of lakes, woods and mountains until it reaches the flat country of the south shore of the St. Lawrence. It crosses that river by the great Lachine Bridge, which has two channel spans of 408 ft., with through trusses, the rest of the bridge being composed of deck spans. The long trestle approach on the south side has now been almost entirely replaced with a solid bank, and on the north side three masonry arches are being constructed under the railway preparatory to filling in the bank.

In leaving St. John the railway crosses the St. John river by a cantilever bridge having through trusses. The river here pours through a rocky gorge only about 500 ft. wide, and at low tide it has a fall of about 15 to 20 ft. at the mouth of the gorge. At high tide, however, the fall is reversed, and the water from the Bay of Fundy pours into the river with a fall of about 15 ft. The bridge is peculiar in having unequal arms. It was built in 1883 and 1884, and was opened early in the summer of 1884. It was built by the Dominion Bridge Co., of Montreal, of which Mr. Job Abbott was then President and Chief Engineer, and Mr. P. S. Archibald was engineer for the railway company. The erection of the towers and shore arms was done by a derrick tower 100 ft. high, 24 ft. long and 16 ft. wide, carried on temporary tracks of 14 ft. gage. A hoisting engine with eight drums was set up on a truck 8 ft. high, on the derrick track, to allow material to be run in below on the railway track. The erection of the channel spans was done from a crane on the top chords, the arm of the crane projecting 36 ft., or 1½ panel lengths. The crane moved on temporary timbers and was supported on the post heads. A hoisting engine with eight drums was arranged in the same way as on the shore arms. Fig 2 is from a view taken during the erection. Close to this bridge is a suspension bridge for a highway, as shown in the accompanying view. The approach on the west side is a plate girder viaduct 395 ft. long. This bridge was the first through cantilever span ever built. The Fraser River bridge, in British Columbia, was built before it, but this is a deck bridge, as is also the Niagara cantilever bridge, which was built at about the same time as the St. John bridge. The leading dimensions of the St. John bridge are as follows:

Total length	813 ft.
Center span	477 "
West shore arm and west cantilever arm	191 "
East short arm and east cantilever arm	143 "
Suspended span	143 "
Width, center to center of trusses	20 "
Depth of west cantilever over pier	80 "
Depth of east cantilever over pier	65 "
Depth of cantilevers at center	27 "
Height above low water	96 "
Wind pressure	40 lbs. per sq. ft.
Rolling load	2,500 lbs. per ft., and two engine loads of 90,000 lbs. on 14-ft. wheelbases, 48 ft. apart on centers

The sleeping car "Katahdin," on the train from St. John to Montreal, which was built by the Barney & Smith Mfg. Co., of Dayton, O., is one of the few which the writer has seen in which the upper berths have light from the car windows. Pullman and Wagner cars have usually a piece of ornamental (and useless) glass above the sashes, but in this car there was a rectangular piece of clear glass above each of the sashes, the dividing strip being about level with the bottom of the upper berth. The occupant of this berth finds at his side two panels marked "To open, Lift up," and on sliding these panels up into the space behind the name board, he finds two windows (not sashes), affording him a view of the country. In view of the acknowledged inconveniences of sleeping cars in regard to ventilation, and the consequent discomfort in hot weather, it would seem that this arrangement might well be developed, so as to give a small separate sash for the upper berth, with adjustable ventilating appliances. In this way the occupants of the upper berths might, like their more fortunate companions in the lower berths, have fresh air from outside, instead of

breathing only the air of the car, but little diluted with fresh air entering through the deck light.

The new terminal station at Dalhousie Square, Montreal, described and illustrated in our issue of Dec. 31, 1896, is well advanced towards completion. It is of yellow brick and gray stone. The yards, however, are not yet graded. The union station at Toronto is a good example of modern development in railway stations. It is only a few years ago that there were grade crossings at each end of the station, and that the station and yards were open to everybody. Now a new station has been built on the old site (as described in Engineering News), the main tracks and yards have been fenced in, and bridges and viaducts carry the streets across the tracks. There is also a complete switch and signal interlocking plant, which, like many of the appliances on Canadian railways, is of English make.

The Canadian Pacific Ry. has always taken the aggressive against the Grand Trunk Ry., and has invaded all the latter's territory. It has gone down to New England and the eastern provinces, has acquired the parallel line to Ottawa which the Grand Trunk Ry. so much desired, and has extended on to Windsor to connect with the Wabash R. R. at Detroit for a through route from Montreal and Toronto to Chicago, 863 miles, thus competing with the through route of the Grand Trunk Ry. and the Chicago & Grand Trunk Ry. This route was opened in 1893. The line to Windsor is well built, and has an easy-riding track, of the company's standard type, but it must be said that the roadbed is most unpleasantly dusty. Some of the cuts are through a treacherous stuff which is apparently stable enough when baked dry by the summer sun, but which a very little moisture will transform into a sliding mass. It is difficult to maintain any semblance of ditches in these cuts. Low retaining walls are built of longitudinal timbers supported by posts heavily braced from the roadbed, but these are pushed out of line and out of shape. The track crossings at grade are protected by interlocking plants, with home and distant signals and derails, the derail connecting with a guard-rail parallel to and about 12 ins. from the running rail, so as to prevent a derailed train from getting off the roadbed.

Between Windsor, Ont., and Detroit, Mich., the trains are carried across the Detroit River by side-wheel steam ferry-boats or car transfer boats. The railway has two of these vessels, the "Michigan" and the "Ontario," built by Polson & Co. and Wheeler & Co. Each vessel has two independent direct-acting engines, one to each wheel, and steam is supplied by four boilers 13 ft. 3 ins. diameter and 14 ft. long, each boiler having three corrugated flues 3 ft. 4 ins. diameter. The leading dimensions are as follows:

Car Ferry Steamers; C. P. Ry.

Length on deck	295 ft.
Beam of hull	41 "
Width of deck over guards	71 "
Depth of hull below deck	17 "
Draft, loaded	9 ft. 11 ins.
Speed, average	12 miles per hour.
Engines	2,500 HP.
Cylinders	4 ft. 2 ins. × 9 ft. 6 ins.
Boiler pressure	170 lbs.
Wheels (20 buckets), diameter	28 ft.
" size of buckets	4 ins. × 2 ft. 6 ins. × 9 ft. 3 ins.
Number of tracks	2
" passenger cars carried	8
" freight cars carried	16

(To be continued.)

THE FAILURE OF A LARGE COAL BIN AT PATERSON, N. J.

The Edison Electric Illuminating Co.'s station plant at Paterson, N. J., recently met with a peculiar accident which, while causing an interruption of its excellent service, may in the long run be advantageous to both the company and the citizens of Paterson, who previously had no idea how important a part electricity plays in their daily life. The fact that a serious accident could be met and remedied in such a short time has inspired a feeling of confidence in citizens and patrons of the company that is most gratifying. The accident referred to was the failure, on Aug. 14, of a large coal storage bin in the boiler-house which let out a perfect flood of coal on top of boilers, steam pipes, etc., and caused a large amount of breakage.

The plant as it now stands is the result of a natural growth which started during 1888, when the present Edison Company was formed as a competitor of the then existing Paterson Electric Light Co. After the usual struggle between rival companies extending over a period of two years, the Edison Company absorbed the other and the two stations were continued under one management, the Paterson station carrying only the arc lights. The constantly growing demand for current and the closing of contracts for supplying street railways taxed the then existing plants beyond their capacity, and in 1894 the general manager, Mr. William M. Brock, was authorized to determine upon some plan of action. As a result of his skill and foresight, the Edison Illuminating Co. has a light and power plant comparable with anything in the country for completeness of design and general excellence of construction. Owing to the company's previous experience, ample provision for growth was considered advisable, and the plant of to-day is well able to meet the rapidly-increasing demands of Paterson for years to come.

The entire building, including offices, storerooms, engine and boiler rooms, is 384 ft. long by 92 ft. wide, and is a substantial and attractive structure. The boiler-room, where the accident happened, is a separate building about 105 × 80 ft., connected to the main structure by the washroom, oil-room, etc. The original design calls for two rows of boilers facing each other, but at present only one row is installed, consisting of six 500-HP. Stirling water-tube boilers working at 150 lbs. pressure. The smoke flues from each boiler lead from the back of the boilers into a Green economizer placed against the wall at the rear of the row of boilers. Other devices, such as water meters, coal hopper scales, etc., are employed to prevent wastes and reduce operating expenses. The coal supply is so arranged as to save all shoveling until the coal is emptied upon the floor from the bin above. Briefly, all the coal was dumped from the wagons or carts directly into a hopper outside the station, and was carried by means of a Hunt conveyor up and over a long iron bin about 105 ft. long, 32 ft. wide and 19 ft. deep, into which it was automatically emptied by a device which could be adjusted to any position along the bin and thus distribute the coal evenly. This bin extended the length of the room, its bottom being on a level with the top of the boilers, while its flaring sides overhung on one side the boilers fully half their length, and on the other, the space where boilers will be placed as the plant grows. From the bottom extended down in front of each boiler a chute which was arranged to weigh the coal used, and could be emptied as needed, thus permitting the floor to be kept free and clean.

The design and construction of this bin was left entirely to Milliken Bros., 39 Cortlandt St., N. Y., the contractors for all the iron-work of the plant. This was done, notwithstanding the fact that their estimates were higher than some other builders, for it was considered well to have one firm do as much of the work as possible. In outline the bin was as shown in cross-section by Fig. 1, built of I-beams, anglebars and sheet iron supported upon five sets of columns. The small vertical sides forming the top of the bin were built of angle iron studs held in position by a channel iron on top.

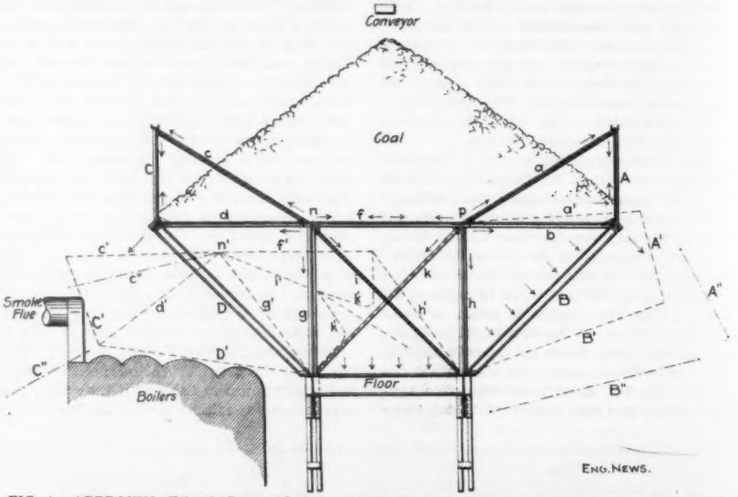


FIG. 1.—APPROXIMATE SECTION OF COAL STORAGE BIN, EDISON ELECTRIC ILLUMINATING CO., PATERSON, N. J.

Showing one of the trusses. Dotted lines represent position of parts after failure.

A heavy I-beam ran longitudinally at the junction of the vertical and inclined sides. The pressure of the coal upon the sides was thus carried to these heavy I-beams, and these were supported by a system of angle iron bracing shown in section by Fig. 1. The inclined sides consisted of a framing of I-beams spaced about 2 ft. apart, and secured at their lower end to the floor beams, while their upper ends were secured to the heavy I's already mentioned. It is thus seen that a considerable amount of the weight in the bin was borne by these angle iron tension members, and a failure of one in any part of the bin would be apt to cause the fall of a large section of both sides.

About the only condition imposed upon the contractor was that the bin should be capable of safely sustaining a load of from 1,000 to 1,200 tons of coal, and since its construction no occasion demanding the storage of such a large quantity has arisen. Recently, however, on account of the coal strikes, the possibility of a shortage was foreseen; it was deemed advisable to fill the bin and be prepared for any contingency that might arise. This was being done, and on the day of the accident about 1,000 tons had been elevated and distributed by the conveyor when, at a few minutes before 4

Fig. 2.—Boiler Room of the Edison Electric Illuminating Co., Paterson, N. J., After the Accident of Aug. 14.

View looking from front to rear, showing floor-columns unharmed, side plates hanging at ends, side A thrown to one side and pile of coal covering B.

p. m., without the least warning, one of the sides gave way, and the immense weight of coal poured down over the floor, boilers and pumps. The falling beams and parts of the bin broke the 12-in. steam pipes, and in an instant the large room was full of hissing steam and flying water. Of the 20 men constituting the engineering force, in and about the building, it so happened that two firemen were the only ones in the boiler-room at the time of the fall. One of these men was looking in the direction of the bin and saw the break occur, or at least saw where it had occurred, for the whole affair was but the work of an instant. The other fireman was in the alley, behind the boilers, between them and the economizer, but could not observe the first break. Both men were caught by the flowing coal and the one behind the boiler was completely buried.

As soon as the steam would permit access to the building the two men, fortunately neither of them seriously hurt, were removed and a rapid survey of the damage was made. Mr. Brock, the Superintendent and General Manager, who was taking his vacation at Greenwood Lake, and the Assistant-Superintendent were sent for by the chief engineer, who, in the absence of his superiors, at once took charge, ordered teams and shovel handlers, and began the work of removing the coal. Lanterns, lamps and headlights from the then useless street cars were pressed into service, and the work of repair continued all night. At 8 p. m., Manager Brock arrived and immediately assumed direction. More men were secured, new fittings of all sorts likely to be needed were telegraphed for, and everything that skill and money could do was done to make the delay as short as possible. Through the united efforts of all interested the wreck was cleared away, temporary steam fittings placed and two boilers put in working condition by the morning of Aug. 16, 36 hours after the accident. This was considerably more of a task than a mere statement of it would indicate, and reflects great credit on the Superintendent, Mr. Brock, and his assistants.

Now that the accident is a thing of the past and the plant is again in operation, though still crippled, only two things remain for the company, first to put their plant in its usual working order, and second, to place the blame. To the engineering profession as a whole, the accomplishment of these duties possesses little or no interest, but there is afforded for them an excellent opportunity to learn something regarding large bin construction.

Looking at the accident in a general way, without knowing any of the previous conditions, it is seen that the possible causes are numerous. For example: it is possible that there may have been an overload, the bin may have been in a weakened condition due to a lack of care, permitting of rusting, or actual abuse may have strained or broken parts. Again, wrong principles of design may have been employed or errors in calculation made, poor material or poor workmanship or a combination of these causes may have conspired to wreck the bin. The first possible cause, that of overloading, is settled definitely by Mr. Brock's positive statement that there was not over 1,000 tons in the bin at the time of the accident. The second, namely, abuse, etc., can be answered at once, for there is positive evidence that no more rusting had occurred than should have been expected with coal which must at times be handled in a more or less wet condition, and again, as buckwheat coal was the only fuel used, it is probable that no banging or forcing of stays could have occurred.

Regarding the assumptions used in its design, we hope to be able to present information in our next issue. For the present this question must be left open, as must also the question of poor material, which would hinge to some extent on the design. In other words, what would be poor material in one case, might in another, when a larger factor of safety was employed, be all that could be asked, at least from the standpoint of safety. It is a trifle uncertain to attempt to determine the existence of poor workmanship when examining such a tangled wreck as was to be found when the coal was cleared away, and a misshaped hole in such a case must as a rule be charged to other causes than the use of drifts. Many would question the use of bolts in any structure of this kind which is subjected to a certain amount of vibration and dampness. This does not mean that they were used throughout, but some were used, as may be seen at N, in the photographs. So much for a resume of possible causes, but it yet remains to consider the way the collapse occurred, for cause and effect are usually so closely related that frequently a careful study of the results will throw positive light upon the causes leading to such results.

Referring to Fig. 1, which is an approximate scale, sectional view of one of the truss frames supporting the sides, and bearing in mind the general construction of the bin, given above, it will be noticed that the letters shown correspond with those of the photographs which will be employed to follow the progress of the failure. All testimony and indications show that the side furthest from the boilers gave way first, and that the break occurred about in the middle. This is clearly shown in Fig. 2, in which the side sheets can be seen hanging from the ends which are still standing. As the conveyor emptied over the center of the bin, the question at once arises, why should this side give away? In case the bin was loaded beyond its safe capacity, a break would be expected, and were all parts equally strong, it would occur where the greatest load came. Owing to the fact that the coal was damp or wet it is possible that there was a heaping on one side, as shown in Fig. 1, or it is also possible that the conveyor may have emptied enough off center to cause a greater weight to come on that side. This latter reason is, however, not probable. Had there been a weak spot in the center of the failed side, due either to faulty construction or poor material, some such failure as did occur would be expected.

To follow the action it is not necessary to question the starting cause, for the evidence afforded by inspection and the photographs here presented is conclusive. Referring to Fig. 1, suppose the tension member (b) should break from any cause whatsoever, and at any position in its length, it is evident that (a) would hold for an instant or so during which time the mass of coal would cause A and B to fall, and at some stage in the proceedings a, A and B would have reached a position a' A' B'. By this time the riveted joints at the ends of A and B would be strained to the breaking point, and A, B and a would have been torn apart, as seen at A'' and B''. The rush of coal following the giving away of any point would naturally tend to carry everything before it, and such was the case. If the action was as so far outlined it would lead to the conclusion that the section or side B was on the fire-room floor and A thrown against the wall or to one side. This is actually the case at all events, for in Fig. 2 the section marked A can be seen, while B is nowhere in sight, and must, therefore, be under the pile of coal, also seen in the same figure. Turning to the other side it is quite clear that owing to the construction, as shown by figure, any break in the member (bfd) could only be followed by the fall of this side as well. The instant the tension to the right of (p) was removed, and before the coal could all pour out on the right side, the left side C, D, with nothing but the frail brace (i) to support it, fell out on the top of the boilers, as shown by the dotted lines C' D' c', d' g' i', etc. Fig. 1, and also by the photograph Fig. 3, where C can be clearly seen standing.

In the center of the bin where the force exerted by the sliding coal was greatest, and where there happened to be no smoke flues, the side (c) broke free from both c and D, and folded back, allowing the coal to pour down behind the boilers. It was this which buried the second fireman, who was working in this alley, as already described. By referring to Figs. 2 and 3, which are lettered to correspond with the other drawings, the relative positions of the different members can be seen just as they were after the accident. As a further proof of the fact that the break occurred at the meeting point of A and B, attention is called to Fig. 2, which shows the bottom framing standing

Fig. 3.—Looking from Front to Rear.
Showing at the far end sides C and D, the destruction of steam pipes and distortion of trusses.

Fig. 4.—Looking from Rear to Front.
Showing distortion of trusses and the bolts used in construction.

VIEW IN THE BOILER ROOM OF THE EDISON ELECTRIC ILLUMINATING CO., PATERSON, N. J., AFTER ACCIDENT O F AUG. 14.

and the flange of the I-beam to which the side I's were secured bent down.

There are a number of peculiar features connected with the accident which are worthy of note. The complete destruction of the bin could have hardly been expected, and certainly inspires a feeling that the whole upper structure was weak or incorrectly designed. It was due without doubt to the fact that the tension members were fastened to anchor plates or gussets that were simply sandwiched between the ends of the I-beams, to which A, B and C, D were fastened, and as soon as the rivets, or bolts, connecting were broken by the straining of one section the plate slipped out and let the next section down. The fact that the columns show no indications of being sprung, notwithstanding the fact that a great weight of coal poured first to one side and then to the other, would indicate that the two sides must have gone down very nearly together; even so, the strains must have been enormous and the under framing was evidently very rigid.

While the exact cause of the accident is still in doubt, as we have already stated; and while a statement as to the methods and assumptions adopted in the design of this structure would be of interest to the profession, the real lesson of the accident—that great care should be taken in the design of all such structures—remains the same in any event. Methods of computing the pressure exerted by the coal should be adopted which will provide for the maximum strain that can occur under any conditions, and if possible a design should be chosen in which the failure of a single member will not involve the whole in ruin.

THE GARBAGE DISPOSAL PLANT AT SHOREDITCH, LONDON.

A few weeks ago there was put in service at Shoreditch, London, what is probably the most elaborate plant for the disposal of garbage that has ever been erected. It was built by the Shoreditch vestry authorities, at a cost of about $750,000, and is located on ground owned by the city adjacent to the public bath-house and laundry. The Shoreditch plant is a cremation plant; but the waste heat from the combustion of the garbage is made use of to raise steam which drives dynamos that furnish current for street lighting. Of course the dynamos can only be run for this purpose a few hours out of the 24, hence the Druitt Halpin system of heat storage is adopted. The steam made by the boilers is used to heat water stored under high pressure in huge cylindrical tanks when the dynamos are not running. During the hours of street lighting the stored heat is utilized by reducing the pressure in these tanks and drawing off the steam that forms. There are also arrangements for storing garbage for a time. The boilers used are 6 Babcock & Wilcox boilers, with about 1,300 sq. ft. of heating surface each. These furnish steam for three Willans engines driving 160 K-W. generators. We have commented upon this plant in our editorial columns.

THE INTAKE CRIB FOR THE NORTHWEST waterworks tunnel at Chicago, Ill., was towed into place and successfully sunk on Aug. 12, by Fitzsimons & Connel, the contractors for the submarine portion of the tunnel. This structure is cylindrical in form and consists of a submerged portion of wood surmounted by two concentric steel shells, the annular space of which will ultimately be filled with concrete. The wooden portion is 112 ft. in diameter and 27 ft. deep, 6 ft. of the depth being taken up by the solid timber bottom and the remaining 21 ft. being a circular timber wall 25 ft. thick, which leaves an interior well 62 ft. in diameter. The two steel shells are carried upward 20 ft. on the inner and outer perimeters of the wooden wall, or 25 ft. apart, the annular space being divided into 24 compartments by diaphragms of steel used to brace the shells apart. Steel plates ½-in. thick are used for the shells and diaphragms, all joints being reinforced by T-bars and the connections of the shells and diaphragms being stiffened by gusset plates. Altogether 2,500,000 ft. B. M. of hemlock timber were used in the structure. The crib was built on shore and towed to its position three miles out in Lake Michigan by means of two tug boats. After being accurately located over its site the crib was sunk by the simple process of pumping water into the interior well. Afloat the crib drew about 29 ft. of water and the depth of water where it was sunk was only about 6 ft. more than this. After being sunk several scow loads of stone were dumped outside of the crib to prevent it from shifting its position. The line of the tunnel is about 100 ft. below the surface of the water at the crib and it will be reached by a 6-ft. shaft cut through the wooden bottom and continued through the clay. The inlet ports of the crib, when it is completed, will be about 6 ft. from the bottom.

THE CITY OF PHILADELPHIA AND THE SCHUYLkill Navigation Co. are made the subject of an exhaustive opinion handed down by City Solicitor Kinsey, in connection with a proposed ordinance providing for the acquisition by the City of Philadelphia of the rights and franchises of the Navigation Company. Mr. Kinsey is against the ordinance, and summarizes his opinion by saying that such acquisition will not relieve the city from liability for interfering with navigation; that the city has no right or means to succeed the navigation company in providing or preserving navigable conditions; that the sale or transfer by contract of the property of the navigation company would be illegal and void; and that the taking of this property by the right of eminent domain is of doubtful validity in the light of present legislation upon the subject.

THE HUDSON RIVER TUNNEL MORTGAGES, aggregating $2,750,000, say Lord, Day & Lord, will be foreclosed very soon, and an effort will then be made to raise money on another mortgage of $2,500,000 with which to complete the work of construction. It is expected that both English and American capital will be secured, and that work can be so pushed as to finish the tunnel by the end of next year.

THE MONONGAHELA RIVER TRAFFIC is increasing since navigation was made free by government purchase, says the Pittsburg "Gazette." In the late report of Major C. F. Powell, Engineer Corps, U. S. A., this officer recommends the rebuilding of Lock 1, the enlargement of Locks 2, 3, 4 and 5, and the raising of all the dams, at an estimated cost of about $2,000,000. He says that the aggregate tonnage of freight, for 1896, on the Monongahela was 5,989,159 tons; principally coal, iron and steel products. The limit of safety on an 8-ft. draft is put at 3,000 tons of freight carried on three coal boats each 175 ft. long by 26 to 27 ft. wide. At present no lock will carry this fleet through without separation at the locks, involving loss of time and detention of other crafts. For these reasons he advocates the enlargement referred to. The charter restriction of the Monongahela Navigation Company, as to the height of dams, no longer exists, and these can now be raised to give an 8-ft. depth in all pools.

THE NEW DRY-DOCK AT PORT ROYAL is to be at last made accessible to our battleships by dredging out the necessary channel for which an appropriation was made some time ago. The delay is said to be due to the time consumed in acquiring a piece of land upon which to deposit the dredged material, and the promise is made that the Navy Department will let the dredging contract early in September.

THE FLORIDA TRANS-PENINSULAR SHIP CANAL Co., organized about nine years ago by Robert M. Caffill, C. E., is again agitating its project. The plans propose a ship canal across Florida, 112 miles long, 200 ft. wide and 30 ft. deep, commencing on the west coast at Turtle Creek, about 20 miles south of Cedar Key, and running northeastwardly through Orange Lake to the St. John's River near Palatka, and down that river to Federal Point, and across to St. Augustine Inlet. The canal would have two locks near the coasts, with a mid-level elevation of 64 ft. above tide. The estimated cost is $75,000,000. It is claimed that it would reduce the sailing distance between New York and New Orleans about 600 miles and make an important part of the proposed Nicaragua canal route.

THE LAKE LOCOMOTIVE SUBMARINE BOAT was launched at the yards of the Columbian Iron Works, in Baltimore, Md., on Aug. 19. This boat, invented by Simon Lake, of Baltimore, is 36 ft. long and 9 ft. diameter and has a displacement of 54 tons. The hull is built of ribbed steel and is calculated to withstand a pressure of 130 lbs. to the sq. in., so that she may work at depths of 300 ft. Steam will be used on the surface and electric storage batteries are to supply power to the propeller when submerged. This boat is supposed to travel over the hard sea bottom by means of two toothed driving-wheels forward and one guide-wheel in the rear; she is fitted with powerful electric lights, a crane at the bow, and an air-lock forward through which divers can pass outside. Water tanks are used to keep her at the bottom; and when these are pumped out and a 3-ton detachable keel is loosened, the boat will rise to the surface. The purpose of the builders is to examine sunken ships and to recover any valuable cargo; the latter is to be lifted by the crane, worked from within the hull, and by this crane loaded into a string of cartridge-like barges, which can be either pumped out and sent to the surface, or pulled ashore by the locomotive boat—according to the plans of the inventor.

THE JAPANESE BATTLESHIP "Yashima," lately built in England, is claimed to be the fastest battleship and one of the most powerful fighting machines afloat. The "Yashima" is 372 ft. long by 73 ft. beam and 26.3 ft. mean draft, with 12,400 tons displacement. On her trial trip, and under 1½-in. air pressure, she made 19.22 knots for four consecutive hours, and 19.46 knots for a single hour.

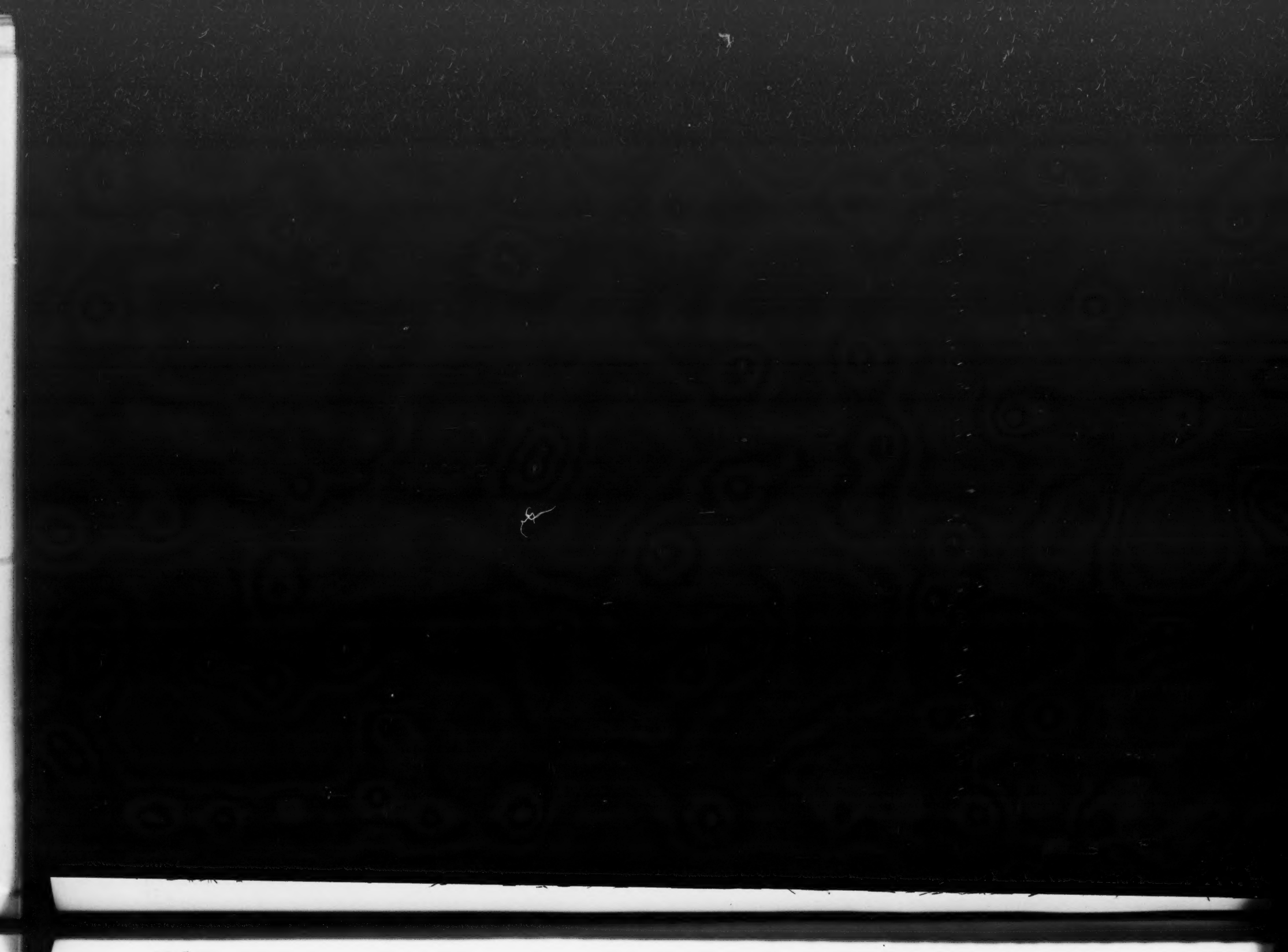
PETROLEUM FOR FUEL IN MARINE ENGINES is to be tested by Lieutenant Nathan Sargent, U. S. N., under the orders of the Secretary of the Navy. Lieutenant Sargent is to investigate the various grades of petroleum produced in this country, and upon his report plans will be drawn up for an oil engine to be placed upon one of the torpedo boats now being built by the Herreshoffs. Among the expected advantages are economy in machine space, and a consequent greater fuel-carrying capacity, economy in cost of fuel and the ability to develop extremely high steam pressure under forced draft.

THE GERLACHE ANTARCTIC EXPEDITION sailed from Antwerp, on Aug. 16, on the steamer "Belgica." It expects to arrive at Graham's Land early in December. The crew consists of 22 men, provisioned for two years.

ARMOR-PLATE AT $150 PER TON can be supplied to the government, if the claims of Mr. J. H. Carpenter, founder of the Carpenter Steel Works of Reading, Pa., can be made good. Mr. Carpenter is the inventor of the Carpenter armor-piercing projectile, furnished to the U. S. government in large quantities, and he was formerly an officer in the U. S. Navy and is an expert in steel. He claims that he has invented a new pneumatic process for cheaply producing steel with uniform chemical and physical properties; with a plant costing less than half that now demanded, and with the steel made in a quarter of the time and at a cost ranging from 1 to 3 cts. per pound. He is to submit his proposals to the Armor Board now in session.

THE CHASSAGNE PROCESS OF COLOR PHOTOGRAphy, which created a small sensation in London last spring and was briefly described in our issue of May 13, proves, as we predicted in describing it, to have been greatly over-estimated in the first published descriptions. Sir Henry Trueman Wood, the British expert in photography, who vouched for the process originally, has recently publicly acknowledged that the process is not an entirely automatic one, as was claimed. "The operator requires to know generally what the colors should be, and the results largely depend on his judgment and skill in applying the color in the right places." He still believes, however, that a certain amount of the "selective absorption" originally claimed for the process does exist, but finds it difficult to justify himself as to how far the process is purely mechanical and how far it is a matter of skill.

THE HISTORY OF THE CROSS-HAIRS IN TRANSITS, etc., is discussed by E. Hammer in the "Zeitschrift fur Vermessungswesen" for 1896. He credits William Gascoigne, of England, with the first use of hairs for this purpose, in 1640, or a little earlier. Gascoigne fell at the battle of Marston Moor in 1644. He speaks of only hair and thread. In 1662 Malvasia employed, besides hair and vegetable fibre, silver wires. In the middle of the last century, glass and mica plates, with engraved lines, were employed in place of cross-hairs; as described by Brander in 1772, and used by Breithaupt in 1780. Spider webs were not thought of until 1775, when their use was advocated by Fontana. In 1818 Struve employed fine glass threads, and platinum, wire has been substituted in recent years.

OFFENSIVE ODORS IN CELLARS ON MADISON AVE., New York, are attributed to an interesting combination of causes by Dr. Edwd. W. Martin, Chief Inspector of Offensive Trades. The conduits of the New York Steam Heating Co. are said to be so poorly insulated that they allow great volumes of heat to escape into the adjacent earth, aiding in the generation of gases. Leaks in sewers and gas mains contribute to the trouble. The asphalt pavement tends strongly to force the gases into the cellars, instead of allowing an exit to the street. Dr. Martin recommends better insulation for the steam pipes, more care in the construction and repair of the various pipes in the street and a new main sewer in Madison Ave., from 59th St., some distance north.

THE ENGLISH CHANNEL WAS CROSSED by a swimmer, Peter McNally, of Boston, Mass., on July 25. He started from Dover for Calais, and covered 35 miles in 15 hours. Owing to strong currents he was carried off Cape Gris Nez, and being blinded by the salt water he was taken aboard a lugger three miles off that Cape. The only other successful attempt to swim the English Channel was that of Capt. Webb, on Aug. 24-25, 1875, who made the passage from Dover to near Calais in 21 h. 45 m. Neither of these men employed any floating or life-saving apparatus.